

## 00. GENERAL

### 01. Communication, education, history, and philosophy

#### 01.10.—m Announcements, news, and organizational activities

- 01.10.Cr Announcements, news, and awards
- 01.10.Fv Conferences, lectures, and institutes
- 01.10.Hx Physics organizational activities

#### 01.20.+x Communication forms and techniques (written, oral, electronic, etc.)

#### 01.30.—y Physics literature and publications

- 01.30.Bb Publications of lectures (advanced institutes, summer schools, etc.)
- 01.30.Cc Conference proceedings
- 01.30.Ee Monographs and collections
- 01.30.Kj Handbooks, dictionaries, tables, and data compilations
- 01.30.Mm Textbooks for graduates and researchers
- 01.30.Pp Textbooks for undergraduates
- 01.30.Rr Surveys and tutorial papers; resource letters
- 01.30.Tt Bibliographies
- 01.30.Vv Book reviews
- 01.30.Xx Publications in electronic media (*for the topic of electronic publishing, see 01.20.+x*)

#### 01.40.—d Education

- 01.40.Di Course design and evaluation
- 01.40.Ej Science in elementary and secondary school
- 01.40.Fk Physics education research (cognition, problem solving, etc.)
- 01.40.Gm Curricula; teaching methods, strategies, theory of testing and evaluation
- 01.40.Jp Teacher training

#### 01.50.—i Educational aids

- 01.50.Fr Audio and visual aids, films
- 01.50.Ht Instructional computer use
- 01.50.Kw Techniques of testing
- 01.50.Lc Laboratory computer use (*see also 01.50.Pa*)
- 01.50.My Demonstration experiments and apparatus
- 01.50.Pa Laboratory experiments and apparatus (*see also 01.50.Lc*)
- 01.50.Qb Laboratory course design, organization, and evaluation
- 01.50.Wg Physics of toys

#### 01.52.+r National and international laboratory facilities

#### 01.55.+b General physics

#### 01.60.+q Biographies, tributes, personal notes, and obituaries

#### 01.65.+g History of science

#### 01.70.+w Philosophy of science

#### 01.75.+m Science and society (*for science and government, see 01.78.+p*)

#### 01.78.+p Science and government (funding, politics, etc.)

#### 01.80.+b Physics of sports

#### 01.90.+g Other topics of general interest (restricted to new topics in section 01)

### 02. Mathematical methods in physics

#### 02.10.—v Logic, set theory, and algebra

- 02.10.Ab Logic and set theory
- 02.10.De Algebraic structures and number theory
- 02.10.Hh Rings and algebras
- 02.10.Kn Knot theory
- 02.10.Ox Combinatorics; graph theory
- 02.10.Ud Linear algebra
- 02.10.Xm Multilinear algebra
- 02.10.Yn Matrix theory

#### 02.20.—a Group theory (*for algebraic methods in quantum mechanics, see 03.65.Fd; for symmetries in elementary particle physics, see 11.30.—j*)

- 02.20.Bb General structures of groups
- 02.20.Hj Classical groups
- 02.20.Qs General properties, structure, and representation of Lie groups
- 02.20.Rt Discrete subgroups of Lie groups
- 02.20.Sv Lie algebras of Lie groups
- 02.20.Tw Infinite-dimensional Lie groups
- 02.20.Uw Quantum groups

#### 02.30.—f Function theory, analysis

- 02.30.Cj Measure and integration
- 02.30.Em Potential theory
- 02.30.Fn Several complex variables and analytic spaces
- 02.30.Gp Special functions
- 02.30.Hq Ordinary differential equations
- 02.30.Ik Integrable systems
- 02.30.Jr Partial differential equations
- 02.30.Ks Delay and functional equations
- 02.30.Lt Sequences, series, and summability
- 02.30.Mv Approximations and expansions
- 02.30.Nw Fourier analysis
- 02.30.Oz Bifurcation theory (*see also 47.20.Ky in fluid dynamics*)
- 02.30.Px Abstract harmonic analysis
- 02.30.Rz Integral equations
- 02.30.Sa Functional analysis

#### 02.30.Tb Operator theory

- 02.30.Uu Integral transforms
- 02.30.Vv Operational calculus
- 02.30.Xx Calculus of variations
- 02.30.Yy Control theory
- 02.30.Zz Inverse problems

#### 02.40.—k Geometry, differential geometry, and topology (*see also section 04 Relativity and gravitation*)

- 02.40.Dr Euclidean and projective geometries
- 02.40.Ft Convex sets and geometric inequalities
- 02.40.Gh Noncommutative geometry
- 02.40.Hw Classical differential geometry
- 02.40.Ky Riemannian geometries
- 02.40.Ma Global differential geometry
- 02.40.Pc General topology
- 02.40.Re Algebraic topology
- 02.40.Sf Manifolds and cell complexes
- 02.40.Tt Complex manifolds
- 02.40.Vh Global analysis and analysis on manifolds
- 02.40.Xx Singularity theory (*see also 05.45.—a in statistical physics, thermodynamics, and nonlinear dynamical systems*)
- 02.40.Yy Geometric mechanics (*see also 45.20.Jj in formalisms in classical mechanics*)

#### 02.50.—r Probability theory, stochastic processes, and statistics (*see also section 05 Statistical physics, thermodynamics, and nonlinear dynamical systems*)

- 02.50.Cw Probability theory
- 02.50.Ey Stochastic processes
- 02.50.Fz Stochastic analysis
- 02.50.Ga Markov processes
- 02.50.Le Decision theory and game theory
- 02.50.Ng Distribution theory and Monte Carlo studies
- 02.50.Sk Multivariate analysis
- 02.50.Tt Inference methods

#### 02.60.—x Numerical approximation and analysis

- 02.60.Cb Numerical simulation; solution of equations
- 02.60.Dc Numerical linear algebra
- 02.60.Ed Interpolation; curve fitting
- 02.60.Gf Algorithms for functional approximation
- 02.60.Jh Numerical differentiation and integration
- 02.60.Lj Ordinary and partial differential equations; boundary value problems
- 02.60.Nm Integral and integrodifferential equations
- 02.60.Pn Numerical optimization

- 02.70.—c Computational techniques** (*for quantum computation, see 03.67.Lx*)
- 02.70.Bf Finite-difference methods
- 02.70.Dh Finite-element and Galerkin methods
- 02.70.Hm Spectral methods
- 02.70.Jn Collocation methods
- 02.70.Ns Molecular dynamics and particle methods
- 02.70.Pt Boundary-integral methods
- 02.70.Rr General statistical methods
- 02.70.Ss Quantum Monte Carlo methods
- 02.70.Tt Justifications or modifications of Monte Carlo methods
- 02.70.Uu Applications of Monte Carlo methods (*see also 02.50.Ng in probability theory, stochastic processes, and statistics, and 05.10.Ln in statistical physics*)
- 02.70.Wz Symbolic computation (computer algebra)
- 02.90.+p Other topics in mathematical methods in physics (restricted to new topics in section 02)**

### 03. Quantum mechanics, field theories, and special relativity (*see also section 11 General theory of fields and particles*)

- 03.30.+p Special relativity**
- 03.50.—z Classical field theories**
- 03.50.De Classical electromagnetism, Maxwell equations (*for applied classical electromagnetism, see 41.20.—q*)
- 03.50.Kk Other special classical field theories
- 03.65.—w Quantum mechanics** (*see also 03.67.—a Quantum information; 05.30.—d Quantum statistical mechanics*)
- 03.65.Ca Formalism
- 03.65.Db Functional analytical methods
- 03.65.Fd Algebraic methods (*see also 02.20.—a Group theory*)
- 03.65.Ge Solutions of wave equations: bound states
- 03.65.Nk Scattering theory
- 03.65.Pm Relativistic wave equations
- 03.65.Sq Semiclassical theories and applications
- 03.65.Ta Foundations of quantum mechanics; measurement theory (*for optical tests of quantum theory, see 42.50.Xa*)
- 03.65.Ud Entanglement and quantum nonlocality (e.g. EPR paradox, Bell's inequalities, GHZ states, etc.) (*for entanglement production in quantum information, see 03.67.Mn; for entanglement in Bose-Einstein condensates, see 03.75.Gg*)

- 03.65.Vf Phases: geometric; dynamic or topological
- 03.65.Wj State reconstruction, quantum tomography
- 03.65.Xp Tunneling, traversal time, quantum Zeno dynamics
- 03.65.Yz Decoherence; open systems; quantum statistical methods (*see also 03.67.Pp in quantum information; for decoherence in Bose-Einstein condensates, see 03.75.Gg*)
- 03.67.—a Quantum information**
- 03.67.Dd Quantum cryptography
- 03.67.Hk Quantum communication
- 03.67.Lx Quantum computation
- 03.67.Mn Entanglement production, characterization and manipulation (*see also 03.65.Ud Entanglement and quantum nonlocality; for entanglement in Bose-Einstein condensates, see 03.75.Gg*)
- 03.67.Pp Quantum error correction and other methods for protection against decoherence (*see also 03.65.Yz Decoherence; open systems; quantum statistical methods; for decoherence in Bose-Einstein condensates, see 03.75.Gg*)
- 03.70.+k Theory of quantized fields** (*see also 11.10.—z Field theory*)
- 03.75.—b Matter waves** (*for atom interferometry techniques, see 39.20.+q—in atomic and molecular physics*)
- 03.75.Be Atom and neutron optics
- 03.75.Dg Atom and neutron interferometry
- 03.75.Gg Entanglement and decoherence in Bose-Einstein condensates
- 03.75.Hh Static properties of condensates; thermodynamical, statistical and structural properties.
- 03.75.Kk Dynamic properties of condensates; collective and hydrodynamic excitations, superfluid flow
- 03.75.Lm Tunneling, Josephson effect, Bose-Einstein condensates in periodic potentials, solitons, vortices and topological excitations
- 03.75.Mn Multicomponent condensates; spinor condensates
- 03.75.Nt Other Bose-Einstein condensation phenomena
- 03.75.Pp Atom lasers
- 03.75.Ss Degenerate Fermi gases

### 04. General relativity and gravitation (*see also 95.30.Sf in astronomy*)

... Special relativity, *see 03.30.+p*

- 04.20.—q Classical general relativity** (*see also 02.40.—k Geometry, differential geometry, and topology*)

- 04.20.Cv Fundamental problems and general formalism
- 04.20.Dw Singularities and cosmic censorship
- 04.20.Ex Initial value problem, existence and uniqueness of solutions
- 04.20.Fy Canonical formalism, Lagrangians, and variational principles
- 04.20.Gz Spacetime topology, causal structure, spinor structure
- 04.20.Ha Asymptotic structure
- 04.20.Jb Exact solutions
- 04.25.—g Approximation methods; equations of motion**
- 04.25.Dm Numerical relativity
- 04.25.Nx Post-Newtonian approximation; perturbation theory; related approximations
- 04.30.—w Gravitational waves: theory**
- 04.30.Db Wave generation and sources
- 04.30.Nk Wave propagation and interactions
- 04.40.—b Self-gravitating systems; continuous media and classical fields in curved spacetime**
- 04.40.Dg Relativistic stars: structure, stability, and oscillations (*see also 97.60.—s Late stages of stellar evolution*)
- 04.40.Nr Einstein–Maxwell spacetimes, spacetimes with fluids, radiation or classical fields
- 04.50.+h Gravity in more than four dimensions, Kaluza–Klein theory, unified field theories; alternative theories of gravity** (*see also 11.25.Mj Compactification and four-dimensional models*)
- 04.60.—m Quantum gravity**
- 04.60.Ds Canonical quantization
- 04.60.Gw Covariant and sum-over-histories quantization
- 04.60.Kz Lower dimensional models; minisuperspace models
- 04.60.Nc Lattice and discrete methods
- 04.60.Pp Loop quantum gravity, quantum geometry, spin foams
- 04.62.+v Quantum field theory in curved spacetime**
- 04.65.+e Supergravity** (*see also 12.60.Jv Supersymmetric models*)
- 04.70.—s Physics of black holes** (*see also 97.60.Lf—in astronomy*)
- 04.70.Bw Classical black holes
- 04.70.Dy Quantum aspects of black holes, evaporation, thermodynamics
- 04.80.—y Experimental studies of gravity**
- 04.80.Cc Experimental tests of gravitational theories
- 04.80.Nn Gravitational wave detectors and experiments (*see also 95.55.Ym—in astronomy*)

**04.90.+e Other topics in general relativity and gravitation (restricted to new topics in section 04)**

**05. Statistical physics, thermodynamics, and nonlinear dynamical systems** (*see also 02.50. –r Probability theory, stochastic processes, and statistics*)

**05.10. –a Computational methods in statistical physics and nonlinear dynamics** (*see also 02.70. –c in mathematical methods in physics*)

05.10.Cc Renormalization group methods

05.10.Gg Stochastic analysis methods (Fokker–Planck, Langevin, etc.)

05.10.Ln Monte Carlo methods (*see also 02.70.Tt, Uu in mathematical methods in physics; for Monte Carlo methods in plasma simulation, see 52.65.Pp*)

**05.20. –y Classical statistical mechanics**

05.20.Dd Kinetic theory (*see also 51.10. +y Kinetic and transport theory of gases*)

05.20.Gg Classical ensemble theory

05.20.Jj Statistical mechanics of classical fluids (*see also 47.10. +g General theory in fluid dynamics*)

**05.30. –d Quantum statistical mechanics**

05.30.Ch Quantum ensemble theory

05.30.Fk Fermion systems and electron gas (*see also 71.10. –w Theories and models of many-electron systems*)

05.30.Jp Boson systems (*for static and dynamic properties of Bose-Einstein condensates, see 03.75.Hh and 03.75.Kk*)

05.30.Pr Fractional statistics systems (anyons, etc.)

**05.40. –a Fluctuation phenomena, random processes, noise, and Brownian motion** (*for fluctuations in superconductivity, see 74.40. +k; for statistical theory and fluctuations in nuclear reactions, see 24.60. –k; for fluctuations in plasma, see 52.25.Gj*)

05.40.Ca Noise

05.40.Fb Random walks and Levy flights

05.40.Jc Brownian motion

**05.45. –a Nonlinear dynamics and nonlinear dynamical systems** (*see also section 45 Classical mechanics of discrete systems*)

05.45.Ac Low-dimensional chaos

05.45.Df Fractals (*see also 47.53. +n Fractals in fluid dynamics*)

05.45.Gg Control of chaos, applications of chaos

05.45.Jn High-dimensional chaos

05.45.Mt Quantum chaos; semiclassical methods

05.45.Pq Numerical simulations of chaotic systems

05.45.Ra Coupled map lattices

05.45.Tp Time series analysis

05.45.Vx Communication using chaos

05.45.Xt Synchronization; coupled oscillators

05.45.Yv Solitons (*see 52.35.Sb for solitons in plasma; for solitons in acoustics, see 43.25.Rq—in acoustics appendix; see 42.50.Md, 42.65.Tg, 42.81.Dp for solitons in optics; see also 03.75.Lm Tunneling, Josephson effect, Bose-Einstein condensates in periodic potentials, solitons, vortices and topological excitations*)

**05.50. +q Lattice theory and statistics (Ising, Potts, etc.)** (*see also 64.60.Cn Order–disorder transformations and statistical mechanics of model systems and 75.10.Hk Classical spin models*)

**05.60. –k Transport processes**

05.60.Cd Classical transport

05.60.Gg Quantum transport

**05.65. +b Self-organized systems** (*see also 45.70. –n in classical mechanics of discrete systems*)

**05.70. –a Thermodynamics** (*see also section 64 Equations of state, phase equilibria, and phase transitions, and section 65 Thermal properties of condensed matter; for chemical thermodynamics, see 82.60. –s; for thermodynamics of plasmas, see 52.25.Kn*)

... Thermodynamics of nanoparticles, *see 82.60.Qr*

05.70.Ce Thermodynamic functions and equations of state (*see also 51.30. +i Thermodynamic properties, equations of state in physics of gases*)

05.70.Fh Phase transitions: general studies

05.70.Jk Critical point phenomena

05.70.Ln Nonequilibrium and irreversible thermodynamics (*see also 82.40.Bj Oscillations, chaos, and bifurcations in physical chemistry and chemical physics*)

05.70.Np Interface and surface thermodynamics (*see also 68.35.Md Surface thermodynamics, surface energies in surfaces and interfaces*)

**05.90. +m Other topics in statistical physics, thermodynamics, and nonlinear dynamical systems (restricted to new topics in section 05)**

**laboratory procedures** (*for laser applications in metrology, see 42.62.Eh*)

**06.20. –f Metrology**

06.20.Dk Measurement and error theory

06.20.Fn Units and standards

06.20.Jr Determination of fundamental constants

**06.30. –k Measurements common to several branches of physics and astronomy**

06.30.Bp Spatial dimensions (e.g., position, lengths, volume, angles, and displacements)

06.30.Dr Mass and density

06.30.Ft Time and frequency

06.30.Gv Velocity, acceleration, and rotation

**06.60. –c Laboratory procedures**

06.60.Ei Sample preparation (including design of sample holders)

06.60.Jn High-speed techniques (microsecond to femtosecond)

06.60.Mr Testing and inspecting procedures

06.60.Sx Positioning and alignment; manipulating, remote handling

06.60.Vz Workshop procedures (welding, machining, lubrication, bearings, etc.)

06.60.Wa Laboratory safety procedures

... National and international laboratory facilities, *see 01.52. +r*

**06.90. +v Other topics in metrology, measurements, and laboratory procedures (restricted to new topics in section 06)**

**07. Instruments, apparatus, and components common to several branches of physics and astronomy** (*see also each subdiscipline for specialized instrumentation and techniques*)

**07.05. –t Computers in experimental physics**

... Computers in physics education, *see 01.50.Ht and 01.50.Lc*

... Computational techniques, *see 02.70. –c—in mathematical methods in physics*

... Quantum computation, *see 03.67.Lx in quantum mechanics*

07.05.Bx Computer systems: hardware, operating systems, computer languages, and utilities

07.05.Dz Control systems

07.05.Fb Design of experiments

07.05.Hd Data acquisition: hardware and software

07.05.Kf Data analysis: algorithms and implementation; data management

**06. Metrology, measurements, and**



07.05.Mh	Neural networks, fuzzy logic, artificial intelligence	07.50.Hp	Electrical noise and shielding equipment	07.68.+m	Photography, photographic instruments; xerography
07.05.Pj	Image processing ( <i>see also</i> 42.30.Va in optics; 87.57. —s <i>Medical imaging: general in biological and medical physics</i> )	07.50.Ls	Electrometers	07.75.+h	Mass spectrometers ( <i>see also</i> 82.80.Ms, 82.80.Nj, and 82.80.Rt in physical chemistry and chemical physics)
07.05.Rm	Data presentation and visualization: algorithms and implementation	07.50.Qx	Signal processing electronics ( <i>see also</i> 84.40.Ua in radiowave and microwave technology)	07.77.—n	Atomic, molecular, and charged-particle sources and detectors
07.05.Tp	Computer modeling and simulation	07.55.—w	Magnetic instruments and components	07.77.Gx	Atomic and molecular beam sources and detectors ( <i>see also</i> 39.10. +j in atomic and molecular physics)
07.05.Wr	Computer interfaces	07.55.Db	Generation of magnetic fields; magnets ( <i>for superconducting magnets, see</i> 84.71.Ba)	07.77.Ka	Charged-particle beam sources and detectors ( <i>see also</i> 29.40. —n in nuclear physics)
07.07.—a	General equipment	07.55.Ge	Magnetometers for magnetic field measurements	07.78.+s	Electron, positron, and ion microscopes; electron diffractometers
07.07.Df	Sensors (chemical, optical, electrical, movement, gas, etc.); remote sensing	07.55.Jg	Magnetometers for susceptibility, magnetic moment, and magnetization measurements	07.79.—v	Scanning probe microscopes and components ( <i>see also</i> 68.37. —d in surfaces and interfaces)
07.07.Hj	Display and recording equipment, oscilloscopes, TV cameras, etc.	07.55.Nk	Magnetic shielding in instruments	07.79.Cz	Scanning tunneling microscopes
07.07.Mp	Transducers	07.57.—c	Infrared, submillimeter wave, microwave and radiowave instruments and equipment ( <i>for infrared and radio telescopes, see</i> 95.55.Cs, 95.55.Fw, and 95.55.Jz in astronomy)	07.79.Fc	Near-field scanning optical microscopes
07.07.Tw	Servo and control equipment; robots	07.57.Hm	Infrared, submillimeter wave, microwave, and radiowave sources	07.79.Lh	Atomic force microscopes
07.07.Vx	Hygrometers	07.57.Kp	Bolometers; infrared, submillimeter wave, microwave, and radiowave receivers and detectors ( <i>see also</i> 85.60.Gz <i>Photodetectors in electronic and magnetic devices, and</i> 95.55.Rg <i>Photoconductors and bolometers in astronomy</i> )	07.79.Pk	Magnetic force microscopes
07.10.—h	Mechanical instruments and equipment	07.57.Pt	Submillimeter wave, microwave and radiowave spectrometers; magnetic resonance spectrometers, auxiliary equipment, and techniques	07.79.Sp	Friction force microscopes
07.10.Cm	Micromechanical devices and systems ( <i>for micro- and nano-electromechanical systems (MEMS/ NEMS), see</i> 85.85. +j in <i>electronic and magnetic devices</i> )	07.57.Ty	Infrared spectrometers, auxiliary equipment, and techniques	07.81.+a	Electron and ion spectrometers ( <i>see also</i> 29.30. —h in nuclear physics)
07.10.Fq	Vibration isolation	07.60.—j	Optical instruments and equipment	07.85.—m	X- and $\gamma$ -ray instruments ( <i>for x- and <math>\gamma</math>-ray telescopes, see</i> 95.55.Ka in astronomy)
07.10.Lw	Balance systems, tensile machines, etc.	· · · ·	Optical sources, <i>see</i> 42.72. —g	07.85.Fv	X- and $\gamma$ -ray sources, mirrors, gratings, and detectors
07.10.Pz	Instruments for strain, force, and torque	· · · ·	Optical elements, devices, and systems 42.79. —e	07.85.Jy	Diffractometers
07.20.—n	Thermal instruments and apparatus	· · · ·	Optoelectronic devices 85.60. —q	07.85.Nc	X-ray and $\gamma$ -ray spectrometers
07.20.Dt	Thermometers	· · · ·	Optical telescopes, <i>see</i> 95.55.Cs	07.85.Qe	Synchrotron radiation instrumentation
07.20.Fw	Calorimeters ( <i>for calorimeters as radiation detectors, see</i> 29.40.Vj)	07.60.Dq	Photometers, radiometers, and colorimeters	07.85.Tt	X-ray microscopes
07.20.Hy	Furnaces; heaters	07.60.Fs	Polarimeters and ellipsometers	07.87.+v	Spaceborne and space research instruments, apparatus, and components (satellites, space vehicles, etc.) ( <i>for aeronomy and magnetospheric instrumentation, see</i> 94.80. +g; <i>see also</i> 95.55.Fw and 95.40. +s in astronomy)
07.20.Ka	High-temperature instrumentation; pyrometers	07.60.Hv	Refractometers and reflectometers	07.88.+y	Instruments for environmental pollution measurements
07.20.Mc	Cryogenics; refrigerators, low-temperature equipment	07.60.Ly	Interferometers	07.89.+b	Environmental effects on instruments (e.g., radiation and pollution effects) ( <i>for environmental effects on optical elements, devices, and systems, see</i> 42.88. +h)
07.20.Pe	Heat engines; heat pumps; heat pipes	07.60.Pb	Conventional optical microscopes ( <i>for near-field scanning optical microscopes, see</i> 07.79.Fc; <i>for x-ray microscopes, see</i> 07.85.Tt)	07.90.+c	Other topics in instruments, apparatus, and components common to several branches of physics and astronomy (restricted to new topics in section 07)
07.30.—t	Vacuum apparatus	07.60.Rd	Visible and ultraviolet spectrometers		
07.30.Bx	Degasification, residual gas	07.60.Vg	Fiber-optic instruments ( <i>see also</i> 42.81. —i <i>Fiber optics—in optics</i> )		
07.30.Cy	Vacuum pumps	07.64.+z	Acoustic instruments and equipment ( <i>see also</i> 43.58. +z—in acoustics)		
07.30.Dz	Vacuum gauges				
07.30.Hd	Vacuum testing methods; leak detectors				
07.30.Kf	Vacuum chambers, auxiliary apparatus, and materials				
07.35.+k	High-pressure apparatus; shock tubes; diamond anvil cells				
07.50.—e	Electrical and electronic instruments and components				
07.50.Ek	Circuits and circuit components ( <i>see also</i> 84.30. —r <i>Electronic circuits and</i> 84.32. —y <i>Passive circuit components</i> )				

# 10. THE PHYSICS OF ELEMENTARY PARTICLES AND FIELDS *(for cosmic rays, see 96.40.—z in astronomy; for experimental methods and instrumentation for elementary-particle physics, see section 29)*

## 11. General theory of fields and particles *(see also 03.65.—w Quantum mechanics and 03.70.+k Theory of quantized fields)*

- 11.10.—z Field theory** *(for gauge field theories, see 11.15.—q)*
- 11.10.Cd Axiomatic approach
- 11.10.Ef Lagrangian and Hamiltonian approach
- 11.10.Gh Renormalization
- 11.10.Hi Renormalization group evolution of parameters
- 11.10.Jj Asymptotic problems and properties
- 11.10.Kk Field theories in dimensions other than four *(see also 04.50.+h Gravity in more than four dimensions; 04.60.Kz Lower dimensional models in quantum gravity)*
- 11.10.Lm Nonlinear or nonlocal theories and models *(see also 11.27.+d Extended classical solutions; cosmic strings, domain walls, texture)*
- 11.10.Nx Noncommutative field theory
- 11.10.St Bound and unstable states; Bethe–Salpeter equations
- 11.10.Wx Finite-temperature field theory
- ... Relativistic wave equations, *see* 03.65.Pm
- 11.15.—q Gauge field theories**
- 11.15.Bt General properties of perturbation theory
- 11.15.Ex Spontaneous breaking of gauge symmetries
- 11.15.Ha Lattice gauge theory *(see also 12.38.Gc Lattice QCD calculations)*
- 11.15.Kc Classical and semiclassical techniques
- 11.15.Me Strong-coupling expansions
- 11.15.Pg Expansions for large numbers of components (e.g.,  $1/N_c$  expansions)
- 11.15.Tk Other nonperturbative techniques
- 11.25.—w Strings and branes** *(for cosmic strings, see 98.80.Cq in cosmology; see also 11.27.+d Extended classical solutions; cosmic strings, domain walls, texture)*
- 11.25.Db Properties of perturbation theory
- 11.25.Hf Conformal field theory, algebraic structures
- 11.25.Mj Compactification and four-dimensional models
- 11.25.Pm Noncritical string theory
- 11.25.Sq Nonperturbative techniques; string field theory
- 11.25.Tq Gauge/string duality
- 11.25.Uv D branes

- 11.25.Wx String and brane phenomenology
- 11.25.Yb M theory
- 11.27.+d Extended classical solutions; cosmic strings, domain walls, texture** *(see also 98.80.Cq in cosmology; 11.25.—w Strings and branes)*
- 11.30.—j Symmetry and conservation laws** *(see also 02.20.—a Group theory)*
- 11.30.Cp Lorentz and Poincaré invariance
- 11.30.Er Charge conjugation, parity, time reversal, and other discrete symmetries
- 11.30.Fs Global symmetries (e.g., baryon number, lepton number)
- 11.30.Hv Flavor symmetries
- 11.30.Ly Other internal and higher symmetries
- 11.30.Na Nonlinear and dynamical symmetries (spectrum-generating symmetries)
- 11.30.Pb Supersymmetry *(see also 12.60.Jv Supersymmetric models)*
- 11.30.Qc Spontaneous and radiative symmetry breaking
- 11.30.Rd Chiral symmetries
- 11.40.—q Currents and their properties**
- 11.40.Dw General theory of currents
- 11.40.Ex Formal properties of current algebras *(see also 12.39.Fe Chiral Lagrangians)*
- 11.40.Ha Partially conserved axial-vector currents
- 11.55.—m S-matrix theory; analytic structure of amplitudes**
- 11.55.Bq Analytic properties of S matrix
- 11.55.Ds Exact S matrices
- 11.55.Fv Dispersion relations
- 11.55.Hx Sum rules
- 11.55.Jy Regge formalism *(see also 12.40.Nn in strong interactions)*
- 11.80.—m Relativistic scattering theory**
- 11.80.Cr Kinematical properties (helicity and invariant amplitudes, kinematic singularities, etc.)
- 11.80.Et Partial-wave analysis
- 11.80.Fv Approximations (eikonal approximation, variational principles, etc.)
- 11.80.Gw Multichannel scattering
- 11.80.Jy Many-body scattering and Faddeev equation
- 11.80.La Multiple scattering

## 11.90.+t Other topics in general theory of fields and particles (restricted to new topics in section 11)

## 12. Specific theories and interaction models; particle systematics

- 12.10.—g Unified field theories and models** *(see also 04.50.+h—in general relativity and gravitation, 11.25.Mj Compactification and four-dimensional models)*
- 12.10.Dm Unified theories and models of strong and electroweak interactions
- 12.10.Kt Unification of couplings; mass relations
- 12.15.—y Electroweak interactions**
- ... Extensions of gauge or Higgs sector, *see* 12.60.Cn or 12.60.Fr
- 12.15.Ff Quark and lepton masses and mixing *(see also 14.60.Pq Neutrino mass and mixing)*
- 12.15.Hh Determination of Kobayashi–Maskawa matrix elements
- 12.15.Ji Applications of electroweak models to specific processes
- 12.15.Lk Electroweak radiative corrections *(see also 13.40.Ks Electromagnetic corrections to strong- and weak-interaction processes)*
- 12.15.Mm Neutral currents
- 12.20.—m Quantum electrodynamics**
- 12.20.Ds Specific calculations
- 12.20.Fv Experimental tests *(for optical tests in quantum electrodynamics, see 42.50.Xa)*
- 12.38.—t Quantum chromodynamics**
- ... Quarks, gluons, and QCD in nuclei and nuclear processes, *see* 24.85.+p
- 12.38.Aw General properties of QCD (dynamics, confinement, etc.)
- 12.38.Bx Perturbative calculations
- 12.38.Cy Summation of perturbation theory
- 12.38.Gc Lattice QCD calculations *(see also 11.15.Ha Lattice gauge theory)*
- 12.38.Lg Other nonperturbative calculations
- 12.38.Mh Quark–gluon plasma *(see also 25.75.Nq Quark deconfinement, quark–gluon plasma production and phase transitions in relativistic heavy ion collisions)*
- 12.38.Qk Experimental tests
- 12.39.—x Phenomenological quark models**
- 12.39.Ba Bag model

12.39.Dc	<i>Skyrmions</i>
12.39.Fe	Chiral Lagrangians
12.39.Hg	Heavy quark effective theory
12.39.Jh	Nonrelativistic quark model
12.39.Ki	Relativistic quark model
12.39.Mk	Glueball and nonstandard multi-quark/gluon states
12.39.Pn	Potential models
12.39.St	Factorization
<b>12.40.-y</b>	<b>Other models for strong interactions</b>
12.40.Ee	Statistical models
12.40.Nn	Regge theory, duality, absorptive/optical models ( <i>see also</i> 11.55.Jy <i>Regge formalism</i> )
12.40.Vv	Vector-meson dominance
12.40.Yx	Hadron mass models and calculations
<b>12.60.-i</b>	<b>Models beyond the standard model</b>
...	<i>Unified field theories and models, see</i> 12.10.-g
12.60.Cn	Extensions of electroweak gauge sector
12.60.Fr	Extensions of electroweak Higgs sector
12.60.Jv	Supersymmetric models ( <i>see also</i> 04.65.+e <i>Supergravity</i> )
12.60.Nz	Technicolor models
12.60.Rc	Composite models
<b>12.90.+b</b>	<b>Miscellaneous theoretical ideas and models (restricted to new topics in section 12)</b>

### 13. Specific reactions and phenomenology

<b>13.15.+g</b>	<b>Neutrino interactions</b>
<b>13.20.-v</b>	<b>Leptonic, semileptonic, and radiative decays of mesons</b>
13.20.Cz	Decays of $\pi$ mesons
13.20.Eb	Decays of $K$ mesons
13.20.Fc	Decays of charmed mesons
13.20.Gd	Decays of $J/\psi$ , $Y$ , and other quarkonia
13.20.He	Decays of bottom mesons
13.20.Jf	Decays of other mesons
<b>13.25.-k</b>	<b>Hadronic decays of mesons</b>
13.25.Cq	Decays of $\pi$ mesons
13.25.Es	Decays of $K$ mesons
13.25.Ft	Decays of charmed mesons
13.25.Gv	Decays of $J/\psi$ , $Y$ , and other quarkonia
13.25.Hw	Decays of bottom mesons
13.25.Jx	Decays of other mesons
<b>13.30.-a</b>	<b>Decays of baryons</b>
13.30.Ce	Leptonic, semileptonic, and radiative decays
13.30.Eg	Hadronic decays

<b>13.35.-r</b>	<b>Decays of leptons</b>
13.35.Bv	Decays of muons
13.35.Dx	Decays of taus
13.35.Hb	Decays of heavy neutrinos
<b>13.38.-b</b>	<b>Decays of intermediate bosons</b>
13.38.Be	Decays of $W$ bosons
13.38.Dg	Decays of $Z$ bosons
<b>13.40.-f</b>	<b>Electromagnetic processes and properties</b>
13.40.Dk	Electromagnetic mass differences
13.40.Em	Electric and magnetic moments
13.40.Gp	Electromagnetic form factors
13.40.Hq	Electromagnetic decays
13.40.Ks	Electromagnetic corrections to strong- and weak-interaction processes
<b>13.60.-r</b>	<b>Photon and charged-lepton interactions with hadrons (<i>for neutrino interactions, see</i> 13.15.+g)</b>
13.60.Fz	Elastic and Compton scattering
13.60.Hb	Total and inclusive cross sections (including deep-inelastic processes)
13.60.Le	Meson production
13.60.Rj	Baryon production
<b>13.66.-a</b>	<b>Lepton-lepton interactions</b>
13.66.Bc	Hadron production in $ee^+$ interactions
13.66.De	Lepton production in $ee^+$ interactions
13.66.Fg	Gauge and Higgs boson production in $ee^+$ interactions
13.66.Hk	Production of non-standard model particles in $ee^+$ interactions
13.66.Jn	Precision measurements in $ee^+$ interactions
13.66.Lm	Processes in other lepton-lepton interactions
<b>13.75.-n</b>	<b>Hadron-induced low- and intermediate-energy reactions and scattering (energy <math>\leq 10</math> GeV) (<i>for higher energies, see</i> 13.85.-t)</b>
13.75.Cs	Nucleon-nucleon interactions (including antinucleons, deuterons, etc.) ( <i>for <math>N</math>-<math>N</math> interactions in nuclei, see</i> 21.30.-x)
13.75.Ev	Hyperon-nucleon interactions
13.75.Gx	Pion-baryon interactions
13.75.Jz	Kaon-baryon interactions
13.75.Lb	Meson-meson interactions
<b>13.85.-t</b>	<b>Hadron-induced high- and super-high-energy interactions (energy <math>&gt; 10</math> GeV) (<i>for low energies, see</i> 13.75.-n)</b>
13.85.Dz	Elastic scattering
13.85.Fb	Inelastic scattering: two-particle final states
13.85.Hd	Inelastic scattering: many-particle final states
13.85.Lg	Total cross sections

13.85.Ni	Inclusive production with identified hadrons
13.85.Qk	Inclusive production with identified leptons, photons, or other nonhadronic particles
13.85.Rm	Limits on production of particles
13.85.Tp	Cosmic-ray interactions ( <i>see also</i> 96.40.-z <i>Cosmic rays in astronomy</i> )
<b>13.87.-a</b>	<b>Jets in large-<math>Q^2</math> scattering</b>
13.87.Ce	Production
13.87.Fh	Fragmentation into hadrons
<b>13.88.+e</b>	<b>Polarization in interactions and scattering</b>
<b>13.90.+i</b>	<b>Other topics in specific reactions and phenomenology of elementary particles (restricted to new topics in section 13)</b>

### 14. Properties of specific particles

<b>14.20.-c</b>	<b>Baryons (including antiparticles)</b>
14.20.Dh	Protons and neutrons
14.20.Gk	Baryon resonances with $S=0$
14.20.Jn	Hyperons
14.20.Lq	Charmed baryons
14.20.Mr	Bottom baryons
14.20.Pt	Dibaryons
<b>14.40.-n</b>	<b>Mesons</b>
14.40.Aq	$\Pi$ , $K$ , and $\eta$ mesons
14.40.Cs	Other mesons with $S=C=0$ , mass $< 2.5$ GeV
14.40.Ev	Other strange mesons
14.40.Gx	Mesons with $S=C=B=0$ , mass $> 2.5$ GeV (including quarkonia)
14.40.Lb	Charmed mesons
14.40.Nd	Bottom mesons
<b>14.60.-z</b>	<b>Leptons</b>
14.60.Cd	Electrons (including positrons)
14.60.Ef	Muons
14.60.Fg	Taus
14.60.Hi	Other charged heavy leptons
14.60.Lm	Ordinary neutrinos ( $\nu_e$ , $\nu$ , $\nu_\tau$ )
14.60.Pq	Neutrino mass and mixing ( <i>see also</i> 12.15.Ff <i>Quark and lepton masses and mixing</i> )
14.60.St	Non-standard-model neutrinos, right-handed neutrinos, etc.
<b>14.65.-q</b>	<b>Quarks</b>
14.65.Bt	Light quarks
14.65.Dw	Charmed quarks
14.65.Fy	Bottom quarks
14.65.Ha	Top quarks
<b>14.70.-e</b>	<b>Gauge bosons</b>
14.70.Bh	Photons
14.70.Dj	Gluons
14.70.Fm	$W$ bosons
14.70.Hp	$Z$ bosons

14.70.Pw	Other gauge bosons	14.80.Bn	Standard-model Higgs bosons	14.80.Ly	Supersymmetric partners of known particles
<b>14.80.–j</b>	<b>Other particles (including hypothetical)</b>	14.80.Cp	Non-standard-model Higgs bosons	14.80.Mz	Axions and other Nambu–Goldstone bosons (Majorons, familons, etc.)
		14.80.Hv	Magnetic monopoles		

## 20. NUCLEAR PHYSICS

**21. Nuclear structure** (*for nucleon structure, see 14.20.Dh Properties of protons and neutrons; 13.40.−f for electromagnetic processes and properties; 13.60.Hb for deep-inelastic structure functions*)

**21.10.−k Properties of nuclei; nuclear energy levels** (*for properties of specific nuclei listed by mass ranges, see section 27*)

21.10.Dr Binding energies and masses  
 21.10.Ft Charge distribution  
 21.10.Gv Mass and neutron distributions  
 21.10.Hw Spin, parity, and isobaric spin  
 21.10.Jx Spectroscopic factors  
 21.10.Ky Electromagnetic moments  
 21.10.Ma Level density  
 21.10.Pc Single-particle levels and strength functions  
 21.10.Re Collective levels  
 21.10.Sf Coulomb energies  
 21.10.Tg Lifetimes

**21.30.−x Nuclear forces** (*see also 13.75.Cs Nucleon–nucleon interactions*)

21.30.Cb Nuclear forces in vacuum  
 21.30.Fe Forces in hadronic systems and effective interactions

**21.45.+v Few-body systems**

**21.60.−n Nuclear structure models and methods**

21.60.Cs Shell model  
 21.60.Ev Collective models  
 21.60.Fw Models based on group theory  
 21.60.Gx Cluster models  
 21.60.Jz Hartree–Fock and random-phase approximations  
 21.60.Ka Monte Carlo models

**21.65.+f Nuclear matter**

... Exotic atoms and molecules, *see* 36.10.−k

**21.80.+a Hypernuclei**

**21.90.+f Other topics in nuclear structure** (*restricted to new topics in section 21*)

**23. Radioactive decay and in-beam spectroscopy**

**23.20.−g Electromagnetic transitions**

23.20.En Angular distribution and correlation measurements  
 23.20.Gq Multipole mixing ratios  
 23.20.Js Multipole matrix elements  
 23.20.Lv  $\gamma$  transitions and level energies  
 23.20.Nx Internal conversion and extranuclear effects

23.20.Ra Internal pair production

**23.40.−s decay; double  $\beta$  decay; electron and muon capture**

23.40.Bw Weak-interaction and lepton (including neutrino) aspects (*see also 14.60.Pq Neutrino mass and mixing*)

23.40.Hc Relation with nuclear matrix elements and nuclear structure

**23.50.+z Decay by proton emission**

**23.60.+e decay**

**23.70.+j Heavy-particle decay**

**23.90.+w Other topics in radioactive decay and in-beam spectroscopy** (*restricted to new topics in section 23*)

**24. Nuclear reactions: general**

**24.10.−i Nuclear reaction models and methods**

24.10.Cn Many-body theory  
 24.10.Eq Coupled-channel and distorted-wave models  
 24.10.Ht Optical and diffraction models  
 24.10.Jv Relativistic models  
 24.10.Lx Monte Carlo simulations (including hadron and parton cascades and string breaking models)  
 24.10.Nz Hydrodynamic models  
 24.10.Pa Thermal and statistical models

**24.30.−v Resonance reactions**

24.30.Cz Giant resonances  
 24.30.Gd Other resonances

**24.50.+g Direct reactions**

**24.60.−k Statistical theory and fluctuations**

24.60.Dr Statistical compound-nucleus reactions  
 24.60.Gv Statistical multistep direct reactions  
 24.60.Ky Fluctuation phenomena  
 24.60.Lz Chaos in nuclear systems

**24.70.+s Polarization phenomena in reactions**

**24.75.+i General properties of fission**

**24.80.+y Nuclear tests of fundamental interactions and symmetries**

**24.85.+p Quarks, gluons, and QCD in nuclei and nuclear processes**

**24.90.+d Other topics in nuclear reactions: general** (*restricted to new topics in section 24*)

**25. Nuclear reactions: specific reactions**

**25.10.+s Nuclear reactions involving few-nucleon systems**

**25.20.−x Photonuclear reactions**

25.20.Dc Photon absorption and scattering  
 25.20.Lj Photoproduction reactions

**25.30.−c Lepton-induced reactions**

25.30.Bf Elastic electron scattering  
 25.30.Dh Inelastic electron scattering to specific states  
 25.30.Fj Inelastic electron scattering to continuum  
 25.30.Hm Positron scattering  
 25.30.Mr Muon scattering (including the EMC effect)  
 25.30.Pt Neutrino scattering  
 25.30.Rw Electroproduction reactions

**25.40.−h Nucleon-induced reactions** (*see also 28.20.−v Neutron physics*)

25.40.Cm Elastic proton scattering  
 25.40.Dn Elastic neutron scattering  
 25.40.Ep Inelastic proton scattering  
 25.40.Fq Inelastic neutron scattering  
 25.40.Hs Transfer reactions  
 25.40.Kv Charge-exchange reactions  
 25.40.Lw Radiative capture  
 25.40.Ny Resonance reactions  
 25.40.Qa ( $p$ ,  $\pi$ ) reactions  
 25.40.Sc Spallation reactions  
 25.40.Ve Other reactions above meson production thresholds (energies  $> 400$  MeV)

**25.43.+t Antiproton-induced reactions**

**25.45.−z  $^2\text{H}$ -induced reactions**

25.45.De Elastic and inelastic scattering  
 25.45.Hi Transfer reactions  
 25.45.Kk Charge-exchange reactions

**25.55.−e  $^3\text{H}$ -,  $^3\text{He}$ -, and  $^4\text{He}$ -induced reactions**

25.55.Ci Elastic and inelastic scattering  
 25.55.Hp Transfer reactions  
 25.55.Kr Charge-exchange reactions

**25.60.−t Reactions induced by unstable nuclei**

25.60.Bx Elastic scattering  
 25.60.Dz Interaction and reaction cross sections  
 25.60.Gc Breakup and momentum distributions  
 25.60.Je Transfer reactions  
 25.60.Lg Charge-exchange reactions  
 25.60.Pj Fusion reactions

**25.70.−z Low and intermediate energy heavy-ion reactions**

25.70.Bc Elastic and quasielastic scattering  
 25.70.De Coulomb excitation



25.70.Ef	Resonances	26.50.+x	Nuclear physics aspects of novae, supernovae, and other explosive environments	28.52.—s	Fusion reactors ( <i>see also</i> 52.55.—s, 52.57.—z, and 52.58.—c in physics of plasmas)
25.70.Gh	Compound nucleus	26.60.+c	Nuclear matter aspects of neutron stars	28.52.Av	Theory, design, and computerized simulation
25.70.Hi	Transfer reactions	26.65.+t	Solar neutrinos	28.52.Cx	Fueling, heating and ignition
25.70.Jj	Fusion and fusion–fission reactions			28.52.Fa	Materials
25.70.Kk	Charge-exchange reactions			28.52.Lf	Components and instrumentation
25.70.Lm	Strongly damped collisions			28.52.Nh	Safety
25.70.Mn	Projectile and target fragmentation			28.60.+s	Isotope separation and enrichment
25.70.Pq	Multifragment emission and correlations			28.70.+y	Nuclear explosions ( <i>see also</i> 47.40.—x Compressional flows; shock and detonation phenomena; for radiation protection from fallout, <i>see</i> 87.52.—g in biological and medical physics)
25.75.—q	<b>Relativistic heavy-ion collisions</b> ( <i>collisions induced by light ions studied to calibrate relativistic heavy-ion collisions should be classified under both 25.75.—q and sections 13 or 25 appropriate to the light ions</i> )	27.	<b>Properties of specific nuclei listed by mass ranges</b> ( <i>an additional heading must be chosen with these entries, where the given mass number limits are, to some degree, arbitrary</i> )	28.90.+i	<b>Other topics in nuclear engineering and nuclear power studies (restricted to new topics in section 28)</b>
25.75.Dw	Particle and resonance production	27.10.+h	$A \leq 5$		
25.75.Gz	Particle correlations	27.20.+n	$6 \leq A \leq 19$		
25.75.Ld	Collective flow	27.30.+t	$20 \leq A \leq 38$		
25.75.Nq	Quark deconfinement, quark-gluon plasma production, and phase transitions ( <i>see also</i> 12.38.Mh Quark–gluon plasma in quantum chromodynamics)	27.40.+z	$39 \leq A \leq 58$		
25.80.—e	<b>Meson- and hyperon-induced reactions</b>	27.50.+e	$59 \leq A \leq 89$		
25.80.Dj	Pion elastic scattering	27.60.+j	$90 \leq A \leq 149$		
25.80.Ek	Pion inelastic scattering	27.70.+q	$150 \leq A \leq 189$		
25.80.Gn	Pion charge-exchange reactions	27.80.+w	$190 \leq A \leq 219$		
25.80.Hp	Pion-induced reactions	27.90.+b	$220 \leq A$		
25.80.Ls	Pion inclusive scattering and absorption				
25.80.Nv	Kaon-induced reactions				
25.80.Pw	Hyperon-induced reactions				
25.85.—w	<b>Fission reactions</b>	28.	<b>Nuclear engineering and nuclear power studies</b>		
25.85.Ca	Spontaneous fission	28.20.—v	Neutron physics ( <i>see also</i> 25.40.—h Nucleon-induced reactions and 25.85.Ec Neutron-induced fission)		
25.85.Ec	Neutron-induced fission	28.20.Cz	Neutron scattering		
25.85.Ge	Charged-particle-induced fission	28.20.Fc	Neutron absorption		
25.85.Jg	Photofission	28.20.Gd	Neutron transport: diffusion and moderation		
25.90.+k	<b>Other topics in nuclear reactions: specific reactions (restricted to new topics in section 25)</b>	28.41.—i	<b>Fission reactors</b>		
		28.41.Ak	Theory, design, and computerized simulation		
		28.41.Bm	Fuel elements, preparation, reloading, and reprocessing		
		28.41.Fr	Reactor coolants, reactor cooling, and heat recovery		
		28.41.Kw	Radioactive wastes, waste disposal		
		28.41.My	Reactor control systems		
		28.41.Pa	Moderators		
		28.41.Qb	Structural and shielding materials		
		28.41.Rc	Instrumentation		
		28.41.Te	Protection systems, safety, radiation monitoring, accidents, and dismantling		
		28.50.—k	<b>Fission reactor types</b>		
		28.50.Dr	Research reactors		
		28.50.Ft	Fast and breeder reactors		
		28.50.Hw	Power and production reactors		
		28.50.Ky	Propulsion reactors		
		28.50.Ma	Auxiliary generators		
26.	<b>Nuclear astrophysics</b> ( <i>see also</i> 95.30.—k Fundamental aspects of astrophysics in astronomy)				
26.20.+f	<b>Hydrostatic stellar nucleosynthesis</b> ( <i>see also</i> 97.10.Cv Stellar structure, interiors, evolution, nucleosynthesis, ages in astronomy)				
26.30.+k	<b>Nucleosynthesis in novae, supernovae and other explosive environments</b>				
26.35.+c	<b>Big Bang nucleosynthesis</b> ( <i>see also</i> 98.80.Ft Origin, formation, and abundances of the elements in astronomy)				
26.40.+r	<b>Cosmic ray nucleosynthesis</b>				
				29.	<b>Experimental methods and instrumentation for elementary-particle and nuclear physics</b>
				29.17.+w	Electrostatic, collective, and linear accelerators
				29.20.—c	Cyclic accelerators and storage rings
				29.20.Dh	Storage rings
				29.20.Fj	Betatrions
				29.20.Hm	Cyclotrons
				29.20.Lq	Synchrotrons
				29.25.—t	<b>Particle sources and targets</b> ( <i>see also</i> 52.59.—f in physics of plasmas)
				29.25.Bx	Electron sources
				29.25.Dz	Neutron sources
				29.25.Lg	Ion sources: polarized
				29.25.Ni	Ion sources: positive and negative
				29.25.Pj	Polarized and other targets
				29.25.Rm	Sources of radioactive nuclei
				29.27.—a	<b>Beams in particle accelerators</b> ( <i>for low energy charged-particle beams, see</i> 41.75.—i)
				29.27.Ac	Beam injection and extraction
				29.27.Bd	Beam dynamics; collective effects and instabilities
				29.27.Eg	Beam handling; beam transport
				29.27.Fh	Beam characteristics
				29.27.Hj	Polarized beams
				29.30.—h	<b>Spectrometers and spectroscopic techniques</b>
				29.30.Aj	Charged-particle spectrometers: electric and magnetic
				29.30.Dn	Electron spectroscopy
				29.30.Ep	Charged-particle spectroscopy
				29.30.Hs	Neutron spectroscopy
				29.30.Kv	X- and $\gamma$ -ray spectroscopy

29.30.Lw	Nuclear orientation devices	29.40.Gx	Tracking and position-sensitive detectors	<b>29.50.+v</b>	<b>Computer interfaces</b> ( <i>see also 07.05.Wr in computers in experimental physics</i> )
. . . .	<i>Energy loss and stopping power, see 34.50.Bw and 61.85.+p in atomic and molecular physics and condensed matter, respectively</i>	29.40.Ka	Cherenkov detectors	<b>29.85.+c</b>	<b>Computer data analysis</b>
<b>29.40.-n</b>	<b>Radiation detectors</b> ( <i>for mass spectrometers, see 07.75.+h</i> )	29.40.Mc	Scintillation detectors	<b>29.90.+r</b>	<b>Other topics in elementary-particle and nuclear physics experimental methods and instrumentation</b> (restricted to new topics in section 29)
29.40.Cs	Gas-filled counters: ionization chambers, proportional, and avalanche counters	29.40.Rg	Nuclear emulsions		
		29.40.Vj	Calorimeters		
		29.40.Wk	Solid-state detectors		

## 30. ATOMIC AND MOLECULAR PHYSICS

### 31. Electronic structure of atoms and molecules: theory

- 31.10.+z Theory of electronic structure, electronic transitions, and chemical binding**
- 31.15.–p Calculations and mathematical techniques in atomic and molecular physics (excluding electron correlation calculations)** (*see also 02.70.–c computational techniques, in mathematical methods in physics*)
- 31.15.Ar Ab initio calculations
- 31.15.Bs Statistical model calculations (including Thomas–Fermi and Thomas–Fermi–Dirac models)
- 31.15.Ct Semi-empirical and empirical calculations (differential overlap, Hückel, PPP methods, etc.)
- 31.15.Dv Coupled-cluster theory
- 31.15.Ew Density-functional theory
- 31.15.Fx Finite-difference schemes
- 31.15.Gy Semiclassical methods
- 31.15.Hz Group theory
- 31.15.Ja Hyperspherical methods
- 31.15.Kb Path-integral methods
- 31.15.Lc Quasiparticle methods
- 31.15.Md Perturbation theory
- 31.15.Ne Self-consistent-field methods
- 31.15.Pf Variational techniques
- 31.15.Qg Molecular dynamics and other numerical methods
- 31.15.Rh Valence bond calculations
- 31.25.–v Electron correlation calculations for atoms and molecules**
- 31.25.Eb Electron correlation calculations for atoms and ions: ground state
- 31.25.Jf Electron correlation calculations for atoms and ions: excited states
- 31.25.Nj Electron correlation calculations for diatomic molecules
- 31.25.Qm Electron correlation calculations for polyatomic molecules
- 31.30.–i Corrections to electronic structure**
- 31.30.Gs Hyperfine interactions and isotope effects, Jahn–Teller effect
- 31.30.Jv Relativistic and quantum electrodynamic effects in atoms and molecules
- 31.50.–x Potential energy surfaces** (*for potential energy surfaces for chemical reactions, see 82.20.Kh; for collisions, see 34.20.Mq*)
- 31.50.Bc Potential energy surfaces for ground electronic states
- 31.50.Df Potential energy surfaces for excited electronic states

- 31.50.Gh Surface crossings, non-adiabatic couplings
- 31.70.–f Effects of atomic and molecular interactions on electronic structure** (*see also section 34 Atomic and molecular collision processes and interactions*)
- 31.70.Dk Environmental and solvent effects
- 31.70.Hq Time-dependent phenomena: excitation and relaxation processes, and reaction rates (*for chemical kinetics aspects, see 82.20.Rp*)
- 31.70.Ks Molecular solids
- 31.90.+s Other topics in the theory of the electronic structure of atoms and molecules (restricted to new topics in section 31)**

### 32. Atomic properties and interactions with photons

- 32.10.–f Properties of atoms**
- 32.10.Bi Atomic masses, mass spectra, abundances, and isotopes (*for mass spectroscopy, see 07.75.+h in instruments, and 82.80.Ms, Nj, Rt in physical chemistry and chemical physics*)
- 32.10.Dk Electric and magnetic moments, polarizability
- 32.10.Fn Fine and hyperfine structure
- 32.10.Hq Ionization potentials, electron affinities
- 32.30.–r Atomic spectra**
- 32.30.Bv Radio-frequency, microwave, and infrared spectra
- 32.30.Dx Magnetic resonance spectra
- 32.30.Jc Visible and ultraviolet spectra
- 32.30.Rj X-ray spectra
- 32.50.+d Fluorescence, phosphorescence (including quenching)**
- 32.60.+i Zeeman and Stark effects**
- 32.70.–n Intensities and shapes of atomic spectral lines**
- 32.70.Cs Oscillator strengths, lifetimes, transition moments
- 32.70.Fw Absolute and relative intensities
- 32.70.Jz Line shapes, widths, and shifts
- 32.80.–t Photon interactions with atoms** (*see also 42.50.–p Quantum optics*)
- 32.80.Bx Level crossing and optical pumping
- 32.80.Cy Atomic scattering, cross sections, and form factors; Compton scattering
- 32.80.Dz Autoionization
- 32.80.Fb Photoionization of atoms and ions
- 32.80.Gc Photodetachment of atomic negative ions

- 32.80.Hd Auger effect and inner-shell excitation or ionization
- 32.80.Lg Mechanical effects of light on atoms, molecules, and ions
- 32.80.Pj Optical cooling of atoms; trapping
- 32.80.Qk Coherent control of atomic interactions with photons
- 32.80.Rm Multiphoton ionization and excitation to highly excited states (e.g., Rydberg states)
- 32.80.Wr Other multiphoton processes
- 32.80.Ys Weak-interaction effects in atoms
- 32.90.+a Other topics in atomic properties and interactions of atoms with photons (restricted to new topics in section 32)**

### 33. Molecular properties and interactions with photons

- 33.15.–e Properties of molecules**
- 33.15.Bh General molecular conformation and symmetry; stereochemistry
- 33.15.Dj Interatomic distances and angles
- 33.15.Fm Bond strengths, dissociation energies
- 33.15.Hp Barrier heights (internal rotation, inversion, rotational isomerism, conformational dynamics)
- 33.15.Kr Electric and magnetic moments (and derivatives), polarizability, and magnetic susceptibility
- 33.15.Mt Rotation, vibration, and vibration–rotation constants
- 33.15.Pw Fine and hyperfine structure
- 33.15.Ry Ionization potentials, electron affinities, molecular core binding energy
- 33.15.Ta Mass spectra
- 33.15.Vb Correlation times in molecular dynamics
- 33.20.–t Molecular spectra**
- 33.20.Bx Radio-frequency and microwave spectra
- 33.20.Ea Infrared spectra
- 33.20.Fb Raman and Rayleigh spectra (including optical scattering)
- 33.20.Kf Visible spectra
- 33.20.Lg Ultraviolet spectra
- 33.20.Ni Vacuum ultraviolet spectra
- 33.20.Rm X-ray spectra
- 33.20.Sn Rotational analysis
- 33.20.Tp Vibrational analysis
- 33.20.Vq Vibration–rotation analysis
- 33.20.Wr Vibronic, rovibronic, and rotation–electron-spin interactions
- 33.25.+k Nuclear resonance and relaxation**

	<i>(see also 76.60. -k Nuclear magnetic resonance and relaxation in condensed matter and 82.56. -b in physical chemistry and chemical physics)</i>	33.80.Ps	Optical cooling of molecules; trapping	34.50.Rk	Laser-modified scattering and reactions
33.35.+r	<b>Electron resonance and relaxation</b> <i>(see also 76.30. -v Electron paramagnetic resonance and relaxation in condensed matter)</i>	33.80.Rv	Multiphoton ionization and excitation to highly excited states (e.g., Rydberg states)	34.60.+z	<b>Scattering in highly excited states (e.g., Rydberg states)</b>
33.40.+f	<b>Multiple resonances (including double and higher-order resonance processes, such as double nuclear magnetic resonance, electron double resonance, and microwave optical double resonance)</b> <i>(see also 76.70. -r Magnetic double resonances and cross effects in condensed matter)</i>	33.80.Wz	Other multiphoton processes	34.70.+e	<b>Charge transfer</b> <i>(for charge transfer reactions, see 82.30.Fi in physical chemistry and chemical physics)</i>
33.45.+x	<b>Mössbauer spectra</b> <i>(see also 76.80. +y Mössbauer effect; other x-ray spectroscopy)</i>	33.90.+h	<b>Other topics in molecular properties and interactions with photons (restricted to new topics in section 33)</b>	34.80.-i	<b>Electron scattering</b> <i>(for electron collisions in plasma, see 52.20.Fs in physics of plasmas)</i>
33.50.-j	<b>Fluorescence and phosphorescence; radiationless transitions, quenching (intersystem crossing, internal conversion)</b> <i>(for energy transfer, see also section 34)</i>	34.	<b>Atomic and molecular collision processes and interactions</b> <i>(for atomic, molecular, and ionic collisions in plasma, see 52.20.Hv)</i>	34.80.Bm	Elastic scattering of electrons by atoms and molecules
33.50.Dq	Fluorescence and phosphorescence spectra	34.10.+x	<b>General theories and models of atomic and molecular collisions and interactions (including statistical theories, transition state, stochastic and trajectory models, etc.)</b>	34.80.Dp	Atomic excitation and ionization by electron impact
33.50.Hv	Radiationless transitions, quenching	34.20.-b	<b>Interatomic and intermolecular potentials and forces, potential energy surfaces for collisions</b>	34.80.Gs	Molecular excitation and ionization by electron impact
33.55.-b	<b>Optical activity and dichroism; magneto-optical and electro-optical spectra</b>	34.20.Cf	Interatomic potentials and forces	34.80.Ht	Dissociation and dissociative attachment by electron impact
33.55.Ad	Optical activity, optical rotation; circular dichroism	34.20.Gj	Intermolecular and atom-molecule potentials and forces	34.80.Kw	Electron-ion scattering; excitation and ionization
33.55.Be	Zeeman and Stark effects	34.20.Mq	Potential energy surfaces for collisions <i>(see also 82.20.Kh Potential energy surfaces for chemical reactions; for potential energy surface in electronic structure calculations, see 31.50. -x)</i>	34.80.Lx	Electron-ion recombination and electron attachment
33.55.Fi	Other magneto-optical and electro-optical effects	34.30.+h	<b>Intramolecular energy transfer; intramolecular dynamics; dynamics of van der Waals molecules</b>	34.80.My	Fundamental electron inelastic processes in weakly ionized gases
33.60.-q	<b>Photoelectron spectra</b>	34.50.-s	<b>Scattering of atoms and molecules</b>	34.80.Nz	Spin dependence of cross sections; polarized electron beam experiments
33.60.Cv	Ultraviolet and vacuum ultraviolet photoelectron spectra	34.50.Bw	Energy loss and stopping power	34.80.Pa	Coherence and correlation in electron scattering
33.60.Fy	X-ray photoelectron spectra	34.50.Dy	Interactions of atoms and molecules with surfaces; photon and electron emission; neutralization of ions <i>(for surface characterization by particle-surface scattering, see 68.49. -h in surfaces, interfaces, thin films, and low-dimensional structures)</i>	34.80.Qb	Laser-modified scattering
33.70.-w	<b>Intensities and shapes of molecular spectral lines and bands</b>	34.50.Ez	Rotational and vibrational energy transfer	34.85.+x	<b>Positron scattering</b>
33.70.Ca	Oscillator and band strengths, lifetimes, transition moments, and Franck-Condon factors	34.50.Fa	Electronic excitation and ionization of atoms (including beam-foil excitation and ionization)	34.90.+q	<b>Other topics in atomic and molecular collision processes and interactions (restricted to new topics in section 34)</b>
33.70.Fd	Absolute and relative line and band intensities	34.50.Gb	Electronic excitation and ionization of molecules; intermediate molecular states (including lifetimes, state mixing, etc.)		
33.70.Jg	Line and band widths, shapes, and shifts	34.50.Lf	Chemical reactions, energy disposal, and angular distribution, as studied by atomic and molecular beams		
33.80.-b	<b>Photon interactions with molecules</b> <i>(see also 42.50. -p Quantum optics)</i>	34.50.Pi	State-to-state scattering analyses		
33.80.Be	Level crossing and optical pumping				
33.80.Eh	Autoionization, photoionization, and photodetachment				
33.80.Gj	Diffuse spectra; predissociation, photodissociation				
				36.	<b>Exotic atoms and molecules; macromolecules; clusters</b>
				36.10.-k	<b>Exotic atoms and molecules (containing mesons, muons, and other unusual particles)</b>
				36.10.Dr	Positronium, muonium, muonic atoms and molecules
				36.10.Gv	Mesonic atoms and molecules, hyperonic atoms and molecules
				36.20.-r	<b>Macromolecules and polymer molecules</b> <i>(for polymer reactions and polymerization, see 82.35. -x; for biological macromolecules and polymers, see 87.14. -g and 87.15. -v)</i>
				36.20.Cw	Molecular weights, dispersity
				36.20.Ey	Conformation (statistics and dynamics)
				36.20.Fz	Constitution (chains and sequences)
				36.20.Hb	Configuration (bonds, dimensions)
				36.20.Kd	Electronic structure and spectra
				36.20.Ng	Vibrational and rotational structure, infrared and Raman spectra
				36.40.-c	<b>Atomic and molecular clusters</b>



(see also 61.46.+w in condensed matter)

- 36.40.Cg Electronic and magnetic properties of clusters
- 36.40.Ei Phase transitions in clusters
- 36.40.Gk Plasma and collective effects in clusters
- 36.40.Jn Reactivity of clusters
- 36.40.Mr Spectroscopy and geometrical structure of clusters
- 36.40.Qv Stability and fragmentation of clusters
- 36.40.Sx Diffusion and dynamics of clusters
- 36.40.Vz Optical properties of clusters
- 36.40.Wa Charged clusters
- 36.90.+f Other exotic atoms and molecules; macromolecules; clusters (restricted to new topics in section 36)**

### **39. Instrumentation and techniques for atomic and molecular physics**

- 39.10.+j Atomic and molecular beam sources and techniques**
- 39.20.+q Atom interferometry techniques** (see also 03.75.-b Matter waves, and 03.75.Dg Atom and neutron interferometry in quantum mechanics)
- 39.25.+k Atom manipulation (scanning probe microscopy, laser cooling, etc.)** (see also 82.37.Gk STM and AFM manipulations of a single molecule in physical chemistry and chemical physics; for atom manipulation in nanofabrication and processing, see 81.16.Ta)

- 39.30.+w Spectroscopic techniques** (see also 78.47.+p Time-resolved optical spectroscopies and other ultrafast optical measurements in condensed matter and 82.53.Kp Coherent spectroscopy of atoms and molecules in physical chemistry and chemical physics)
- 39.90.+d Other instrumentation and techniques for atomic and molecular physics (restricted to new topics in section 39)**

## 40. ELECTROMAGNETISM, OPTICS, ACOUSTICS, HEAT TRANSFER, CLASSICAL MECHANICS, AND FLUID MECHANICS

### 41. Electromagnetism; electron and ion optics

#### 41.20.—q Applied classical electromagnetism

- 41.20.Cv Electrostatics; Poisson and Laplace equations, boundary-value problems
- 41.20.Gz Magnetostatics; magnetic shielding, magnetic induction, boundary-value problems
- 41.20.Jb Electromagnetic wave propagation; radiowave propagation (*for light propagation, see 42.25.Bs; for electromagnetic waves in plasma, see 52.35.Hr; for ionospheric and magnetospheric propagation, see 94.20.Bb and 94.30.Ti*)

#### 41.50.+h X-ray beams and x-ray optics (*see also 07.85.Fv in instruments*)

#### 41.60.—m Radiation by moving charges

- 41.60.Ap Synchrotron radiation (*for synchrotron radiation instrumentation, see 07.85.Qe*)
- 41.60.Bq Cherenkov radiation
- 41.60.Cr Free-electron lasers (*see also 52.59.Rz Free-electron devices—in plasma physics*)

#### 41.75.—i Charged-particle beams

- 41.75.Ak Positive-ion beams
- 41.75.Cn Negative-ion beams
- 41.75.Fr Electron and positron beams
- 41.75.Ht Relativistic electron and positron beams
- 41.75.Jv Laser-driven acceleration (*see also 52.38.—r Laser-plasma interactions in plasma physics*)
- 41.75.Lx Other advanced accelerator concepts

#### 41.85.—p Beam optics (*see also 07.77.Ka Charged-particle beam sources and detectors; 29.27.—a Beams in particle accelerators*)

- 41.85.Ar Beam extraction, beam injection
- 41.85.Ct Beam shaping, beam splitting
- 41.85.Ew Beam profile, beam intensity
- 41.85.Gy Chromatic and geometrical aberrations
- 41.85.Ja Beam transport
- 41.85.Lc Beam focusing and bending magnets, wiggler magnets, and quadrupoles (*see also 07.55.Db—in instruments; for superconducting magnets, see 84.71.Ba*)
- 41.85.Ne Electrostatic lenses, septa
- 41.85.Qg Beam analyzers, beam monitors, and Faraday cups
- 41.85.Si Beam collimators, monochromators

#### 41.90.+e Other topics in electromagnetism; electron and ion optics (*restricted to new topics in section 41*)

### 42. Optics (*for optical properties of gases, see 51.70.+f; for optical properties of bulk materials and thin films, see 78.20.—e; for x-ray optics, see 41.50.+h*)

#### 42.15.—i Geometrical optics

- 42.15.Dp Wave fronts and ray tracing
- 42.15.Eq Optical system design
- 42.15.Fr Aberrations

#### 42.25.—p Wave optics

- 42.25.Bs Wave propagation, transmission and absorption (*see also 41.20.Jb—in electromagnetism; for propagation in atmosphere, see 42.68.Ay; see also 52.40.Db Electromagnetic (nonlaser) radiation interactions with plasma and 52.38-r Laser-plasma interactions—in plasma physics*)
- 42.25.Dd Wave propagation in random media
- 42.25.Fx Diffraction and scattering
- 42.25.Gy Edge and boundary effects; reflection and refraction
- 42.25.Hz Interference
- 42.25.Ja Polarization
- 42.25.Kb Coherence
- 42.25.Lc Birefringence

#### 42.30.—d Imaging and optical processing

- 42.30.Kq Fourier optics
- 42.30.Lr Modulation and optical transfer functions
- 42.30.Ms Speckle and moire patterns
- 42.30.Rx Phase retrieval
- 42.30.Sy Pattern recognition
- 42.30.Tz Computer vision; robotic vision
- 42.30.Va Image forming and processing
- 42.30.Wb Image reconstruction; tomography

#### 42.40.—i Holography

- 42.40.Eq Holographic optical elements; holographic gratings
- 42.40.Ht Hologram recording and readout methods (*see also 42.70.Ln Holographic recording materials; optical storage media*)
- 42.40.Jv Computer-generated holograms
- 42.40.Kw Holographic interferometry; other holographic techniques (*see also 07.60.Ly Interferometers*)
- 42.40.Lx Diffraction efficiency, resolution, and other hologram characteristics
- 42.40.My Applications

- 42.40.Pa Volume holograms

#### 42.50.—p Quantum optics (*for lasers, see 42.55.—f and 42.60.—v; see also 42.65.—k Nonlinear optics; 03.65.—w Quantum mechanics*)

- 42.50.Ar Photon statistics and coherence theory
- 42.50.Ct Quantum description of interaction of light and matter; related experiments
- 42.50.Dv Nonclassical states of the electromagnetic field, including entangled photon states; quantum state engineering and measurements (*see also 03.65.Ud Entanglement and quantum nonlocality (e.g. EPR paradox, Bell's inequalities, GHZ states, etc.)*)
- 42.50.Fx Cooperative phenomena in quantum optical systems
- 42.50.Gy Effects of atomic coherence on propagation, absorption, and amplification of light; electromagnetically induced transparency and absorption
- 42.50.Hz Strong-field excitation of optical transitions in quantum systems; multi-photon processes; dynamic Stark shift (*for multiphoton ionization and excitation of atoms and molecules, see 32.80.Rn, and 33.80.Rm, respectively*)
- 42.50.Lc Quantum fluctuations, quantum noise, and quantum jumps
- 42.50.Md Optical transient phenomena: quantum beats, photon echo, free-induction decay, dephasings and revivals, optical nutation, and self-induced transparency
- ... Dynamics of nonlinear optical systems; optical instabilities, optical chaos, and optical spatio-temporal dynamics, *see 42.65.Sf*
- ... Optical solitons; nonlinear guided waves, *see 42.65.Tg*
- 42.50.Nn Quantum optical phenomena in absorbing, dispersive and conducting media
- 42.50.Pq Cavity quantum electrodynamics; micromasers
- 42.50.St Nonclassical interferometry, subwavelength lithography
- 42.50.Vk Mechanical effects of light on atoms, molecules, electrons, and ions (*see also 32.80.Pj and 33.80.Ps Optical cooling and trapping of atoms and molecules, respectively*)



42.72.Bj	Visible and ultraviolet sources	· · · ·	<i>Fiber-optic instruments, see 07.60.Vg</i>	· · · ·	<i>Phonons in crystal lattices, see 63.20. —e</i>
<b>42.79. —e</b>	<b>Optical elements, devices, and systems</b> ( <i>for integrated optics, see 42.82. —m; for fiber optics, see 42.81. —i</i> )	42.81.Bm	Fabrication, cladding, and splicing	· · · ·	<i>Acoustical properties of rocks and minerals, see 91.60.Lj</i>
· · · ·	<i>Optical instruments, equipment and techniques, see 07.60. —j and 07.57. —c</i>	42.81.Cn	Fiber testing and measurement of fiber parameters	· · · ·	<i>Sound waves in plasma, see 52.35.Dm</i>
· · · ·	<i>Optical spectrometers, see 07.57.Ty and 07.60.Rd</i>	42.81.Dp	Propagation, scattering, and losses; solitons	· · · ·	<i>Low-temperature acoustics and sound in liquid helium, see section 67</i>
· · · ·	<i>Photography, photographic instruments and techniques, see 07.68. +m</i>	42.81.Gs	Birefringence, polarization	· · · ·	<i>Acoustical properties of solids, see 62.65. +k; for ultrasonic relaxation, see 62.80. +f</i>
· · · ·	<i>Magneto-optical devices, see 85.70.Sq</i>	42.81.Ht	Gradient-index (GRIN) fiber devices	· · · ·	<i>Acoustic properties of thin films, see 68.60.Bs</i>
42.79.Ag	Apertures, collimators	42.81.Pa	Sensors, gyros	· · · ·	<i>Acoustoelectric effects, see 72.50. +b and 73.50.Rb</i>
42.79.Bh	Lenses, prisms and mirrors	42.81.Qb	Fiber waveguides, couplers, and arrays	· · · ·	<i>Magnetoacoustic effects, oscillations, and resonance, see 72.55. +s, 73.50.Rb, and 75.80. +q</i>
42.79.Ci	Filters, zone plates, and polarizers	42.81.Uv	Fiber networks ( <i>see also 42.79.Sz. Optical communication systems, multiplexers, and demultiplexers</i> )	· · · ·	<i>Acoustic holography, see 43.60.Sx in acoustics appendix; for acoustooptical effects, see 78.20.Hp</i>
42.79.Dj	Gratings ( <i>for holographic gratings, see 42.40.Eq</i> )	42.81.Wg	Other fiber-optical devices ( <i>for fiber lasers, see 42.55.Wd</i> )	<b>43.38. +n</b>	<b>Transduction; acoustical devices for the generation and reproduction of sound</b>
42.79.Ek	Solar collectors and concentrators ( <i>see also 84.60.Jt Photoelectric conversion: solar cells and arrays</i> )	<b>42.82. —m</b>	<b>Integrated optics</b>	<b>43.40. +s</b>	<b>Structural acoustics and vibration</b>
42.79.Fm	Reflectors, beam splitters, and deflectors	42.82.Bq	Design and performance testing of integrated-optical systems	<b>43.50. +y</b>	<b>Noise: its effects and control</b>
42.79.Gn	Optical waveguides and couplers ( <i>for fiber waveguides and waveguides in integrated optics, see 42.81.Qb and 42.82.Et, respectively</i> )	42.82.Cr	Fabrication techniques; lithography, pattern transfer ( <i>see also 85.40. —e Microelectronics: LSI, VLSI, ULSI; integrated circuit fabrication technology</i> )	<b>43.55. +p</b>	<b>Architectural acoustics</b>
42.79.Hp	Optical processors, correlators, and modulators	42.82.Ds	Interconnects, including holographic interconnects ( <i>see also 42.79.Td. Optical computers, logic elements, interconnects, switches; neural networks</i> )	<b>43.58. +z</b>	<b>Acoustical measurements and instrumentation</b>
42.79.Jq	Acousto-optical devices ( <i>see also 43.38.Zp—in acoustics appendix</i> )	42.82.Et	Waveguides, couplers, and arrays ( <i>for fiber waveguides, see 42.81.Qb</i> )	<b>43.60. +d</b>	<b>Acoustic signal processing</b>
42.79.Kr	Display devices, liquid-crystal devices ( <i>see also 85.60.Pg Display systems</i> )	42.82.Fv	Hybrid systems	<b>43.64. +r</b>	<b>Physiological acoustics</b>
42.79.Ls	Scanners, image intensifiers, and image converters ( <i>see also 85.60. —q Optoelectronic devices</i> )	42.82.Gw	Other integrated-optical elements and systems	· · · ·	<i>Biological effects of sound and ultrasound, see 87.50.Kk</i>
42.79.Mt	Schlieren devices	<b>42.86. +b</b>	<b>Optical workshop techniques</b>	<b>43.66. +y</b>	<b>Psychological acoustics</b>
42.79.Nv	Optical frequency converters	<b>42.87. —d</b>	<b>Optical testing techniques</b>	<b>43.70. +i</b>	<b>Speech production</b>
42.79.Pw	Imaging detectors and sensors ( <i>see also 85.60.Gz Photodetectors</i> )	42.87.Bg	Phase shifting interferometry ( <i>see also 07.60.Ly Interferometers</i> )	<b>43.71. +m</b>	<b>Speech perception</b>
42.79.Qx	Range finders, remote sensing devices; laser Doppler velocimeters, SAR, and LIDAR ( <i>see also 42.68.Wt Remote sensing: LIDAR and adaptive systems</i> )	<b>42.88. +h</b>	<b>Environmental and radiation effects on optical elements, devices, and systems</b> ( <i>see also 07.89. +b Environmental effects on instruments</i> )	<b>43.72. +q</b>	<b>Speech processing and communication systems</b>
42.79.Ry	Gradient-index (GRIN) devices ( <i>for fiber GRIN devices, see 42.81.Ht</i> )	<b>42.90. +m</b>	<b>Other topics in optics (restricted to new topics in section 42)</b>	<b>43.75. +a</b>	<b>Music and musical instruments</b>
42.79.Sz	Optical communication systems, multiplexers, and demultiplexers ( <i>for fiber networks, see 42.81.Uv</i> )	<b>43.</b>	<b>Acoustics</b> ( <i>for more detailed headings, see Appendix to section 43</i> )	<b>43.80. +p</b>	<b>Bioacoustics</b>
42.79.Ta	Optical computers, logic elements, interconnects, switches; neural networks	<b>43.20. +g</b>	<b>General linear acoustics</b>	<b>43.90. +v</b>	<b>Other topics in acoustics (restricted to new topics in section 43)</b>
42.79.Vb	Optical storage systems, optical disks ( <i>see also 42.40.Ht Hologram recording and readout methods</i> )	<b>43.25. +y</b>	<b>Nonlinear acoustics</b>	<b>44.</b>	<b>Heat transfer</b>
42.79.Wc	Optical coatings	<b>43.28. +h</b>	<b>Aeroacoustics and atmospheric sound</b> ( <i>see also 92.60. —e Meteorology</i> )	<b>44.05. +e</b>	<b>Analytical and numerical techniques</b>
<b>42.81. —i</b>	<b>Fiber optics</b>	<b>43.30. +m</b>	<b>Underwater sound</b> ( <i>see also 92.10.Vz—in physics of oceans</i> )	<b>44.10. +i</b>	<b>Heat conduction</b> ( <i>see also 66.60. +a and 66.70. +f in transport properties of condensed matter</i> )
		<b>43.35. +d</b>	<b>Ultrasonics, quantum acoustics, and physical effects of sound</b>	<b>44.15. +a</b>	<b>Channel and internal heat flow</b>
				<b>44.20. +b</b>	<b>Boundary layer heat flow</b>
				<b>44.25. +f</b>	<b>Natural convection</b> ( <i>see also 47.27.Te Convection and heat transfer in fluid dynamics</i> )



44.27.+g	Forced convection	45.90.+t	Other topics in classical mechanics of discrete systems (restricted to new topics in section 45)		mechanics of solids ( <i>see also</i> 07.10. −h <i>Mechanical instruments, equipment, and techniques</i> )
44.30.+v	Heat flow in porous media				
44.35.+c	Heat flow in multiphase systems				
44.40.+a	Thermal radiation				
44.90.+c	Other topics in heat transfer (restricted to new topics in section 44)				
<b>45. Classical mechanics of discrete systems</b>		<b>46. Continuum mechanics of solids</b> ( <i>see also</i> 83.10.Ff <i>in rheology</i> )		<b>46.90.+s</b> Other topics in continuum mechanics of solids (restricted to new topics in section 46)	
45.05.+x	General theory of classical mechanics of discrete systems	46.05.+b	General theory of continuum mechanics of solids	<b>47. Fluid dynamics</b> ( <i>for fluid dynamics of quantum fluids, see</i> 67; <i>see also section</i> 83 <i>Rheology; for sound generation by fluid flow, see section</i> 43.28.Ra— <i>in acoustics appendix</i> )	
45.10.−b	Computational methods in classical mechanics ( <i>see also</i> 02.70. −c <i>Computational techniques in mathematical methods in physics</i> )	46.15.−x	Computational methods in continuum mechanics ( <i>see also</i> 02.70. −e <i>Computational techniques in mathematical methods in physics</i> )	<b>47.10.+g</b> General theory ( <i>see also</i> 83.10. −y—in <i>rheology</i> )	
45.10.Db	Variational and optimization methods	46.15.Cc	Variational and optimizational methods	<b>47.11.+j</b> Computational methods in fluid dynamics ( <i>see also</i> 83.85.Pt <i>Computational fluid dynamics—in rheology; 02.70. −c Computational techniques in mathematical methods in physics</i> )	
45.10.Hj	Perturbation and fractional calculus methods	46.15.Ff	Perturbation and complex analysis methods	<b>47.15.−x</b> Laminar flows	
45.10.Na	Geometrical and tensorial methods	46.25.−y	Static elasticity	47.15.Cb	Laminar boundary layers
45.20.−d	Formalisms in classical mechanics	46.25.Cc	Theoretical studies	47.15.Fe	Stability of laminar flows
45.20.Dd	Newtonian mechanics	46.25.Hf	Thermoelasticity and electromagnetic elasticity (electroelasticity, magnetoelasticity)	47.15.Gf	Low-Reynolds-number (creeping) flows
45.20.Jj	Lagrangian and Hamiltonian mechanics	46.32.+x	Static buckling and instability	47.15.Hg	Potential flows
45.30.+s	General linear dynamical systems ( <i>for nonlinear dynamical systems, see</i> 05.45. −a)	46.35.+z	Viscoelasticity, plasticity, viscoplasticity ( <i>see also</i> 83.60.Bc, Df, <i>in rheology</i> )	47.15.Ki	Inviscid flows with vorticity
45.40.−f	Dynamics and kinematics of rigid bodies	46.40.−f	Vibrations and mechanical waves ( <i>see also</i> 43.40. +s <i>Structural acoustics and vibration; 62.30. +d Mechanical and elastic waves; vibrations in mechanical properties of solids</i> )	47.15.Pn	Laminar suspensions
45.40.Cc	Rigid body and gyroscope motion	46.40.Cd	Mechanical wave propagation (including diffraction, scattering, and dispersion)	47.15.Rq	Laminar flows in cavities
45.40.Gj	Ballistics (projectiles; rockets)	46.40.Ff	Resonance, damping and dynamic stability	<b>47.17.+e</b> Mechanical properties of fluids ( <i>see also</i> 62.10. +s <i>Mechanical properties of liquids</i> )	
45.40.Ln	Robotics	46.40.Jj	Aeroelasticity and hydroelasticity	<b>47.20.−k</b> Hydrodynamic stability	
45.50.−j	Dynamics and kinematics of a particle and a system of particles	46.50.+a	Fracture mechanics, fatigue and cracks ( <i>see also</i> 62.20.Mk <i>Fatigue, brittleness, fracture, and cracks in mechanical properties of solids</i> )	47.20.Bp	Buoyancy-driven instability
45.50.Dd	General motion	46.55.+d	Tribology and mechanical contacts ( <i>see also</i> 81.40.Pq <i>Friction, lubrication and wear in materials science; 62.20.Qp Tribology and hardness in mechanical properties of solids</i> )	47.20.Cq	Inviscid instability
45.50.If	Few- and many-body systems	46.65.+g	Random phenomena and media ( <i>see also</i> 05.40. −a <i>in statistical physics, thermodynamics and nonlinear dynamical systems</i> )	47.20.Dr	Surface-tension-driven instability
45.50.Pk	Celestial mechanics ( <i>see also</i> 95.10.Ce <i>in fundamental astronomy</i> )	46.70.−p	Application of continuum mechanics to structures	47.20.Ft	Instability of shear flows
45.50.Tn	Collisions	46.70.De	Beams, plates and shells	47.20.Gv	Viscous instability
45.70.−n	Granular systems ( <i>see also</i> 05.65. +b <i>Self-organized systems</i> )	46.70.Hg	Membranes, rods and strings	47.20.Hw	Morphological instability; phase changes ( <i>see also section</i> 64 <i>Equations of state, phase equilibria, and phase transitions</i> )
45.70.Cc	Static sandpiles; granular compaction	46.70.Lk	Other structures	47.20.Ky	Nonlinearity (including bifurcation theory)
45.70.Ht	Avalanches	46.80.+j	Measurement methods and techniques in continuum	47.20.Lz	Secondary instability
45.70.Mg	Granular flow: mixing, segregation and stratification			47.20.Ma	Interfacial instability
45.70.Qj	Pattern formation			47.20.Pc	Receptivity
45.70.Vn	Granular models of complex systems; traffic flow			· · · ·	Chaotic phenomena, <i>see</i> 47.52. +j <i>and</i> 05.45. −a
45.80.+r	Control of mechanical systems ( <i>see also</i> 46.80. +j <i>Measurement methods and techniques in continuum mechanics of solids</i> )			<b>47.27.−i</b> Turbulent flows, convection, and heat transfer	
				47.27.Ak	Fundamentals
				47.27.Cn	Transition to turbulence
				47.27.Eq	Turbulence simulation and modeling
				47.27.Gs	Isotropic turbulence; homogeneous turbulence
				47.27.Jv	High-Reynolds-number turbulence
				47.27.Lx	Wall-bounded thin shear flows

47.27.Nz	Boundary layer and shear turbulence		effects (for shock wave initiated chemical reactions, see 82.40.Fp)	· · · ·	Biological fluid dynamics, see 87.19.Ti
47.27.Pa	Thick shear flows	<b>47.45.—n</b>	<b>Rarefied gas dynamics</b>	<b>47.62.+q</b>	<b>Flow control</b>
47.27.Qb	Turbulent diffusion	47.45.Dt	Free molecular flows	<b>47.65.+a</b>	<b>Magnetohydrodynamics and electrohydrodynamics</b> (for MHD in plasma, see 52.30.Cv)
47.27.Rc	Turbulence control	47.45.Gx	Slip flows	<b>47.70.—n</b>	<b>Reactive, radiative, or nonequilibrium flows</b>
47.27.Sd	Noise (turbulence generated)	47.45.Nd	Accommodation	47.70.Fw	Chemically reactive flows (see also 83.80.Jx—in rheology)
47.27.Te	Convection and heat transfer (see also 44.25.+f in heat transfer)	<b>47.50.+d</b>	<b>Non-Newtonian fluid flows</b> (see also 83.50.—v Deformation and flow)	47.70.Mc	Radiation gas dynamics
47.27.Vf	Wakes	<b>47.52.+j</b>	<b>Chaos</b> (see also 05.45.—a Nonlinear dynamics and nonlinear dynamical systems; 83.60.Wc Flow instabilities)	47.70.Nd	Nonequilibrium gas dynamics
47.27.Wg	Jets	<b>47.53.+n</b>	<b>Fractals</b>	<b>47.75.+f</b>	<b>Relativistic fluid dynamics</b> (for astrophysical aspects, see 95.30.Lz and 95.30.Qd in astronomy)
<b>47.32.—y</b>	<b>Rotational flow and vorticity</b>	<b>47.54.+r</b>	<b>Pattern selection; pattern formation</b>	<b>47.80.+v</b>	<b>Instrumentation for fluid dynamics</b> (see also 83.85.—c—in rheology; 07.30.—t Vacuum apparatus and techniques)
47.32.Cc	Vortex dynamics	<b>47.55.—t</b>	<b>Nonhomogeneous flows</b>	<b>47.85.—g</b>	<b>Applied fluid mechanics</b>
47.32.Ff	Separated flows	47.55.Bx	Cavitation	47.85.Dh	Hydrodynamics, hydraulics, hydrostatics
<b>47.35.+i</b>	<b>Hydrodynamic waves</b>	47.55.Dz	Drops and bubbles	47.85.Gj	Aerodynamics
<b>47.37.+q</b>	<b>Hydrodynamic aspects of superfluidity</b> (see also 67.40.Hf and 67.57.De—in quantum fluids and solids)	47.55.Hd	Stratified flows	47.85.Kn	Hydraulic and pneumatic machinery
<b>47.40.—x</b>	<b>Compressible flows; shock and detonation phenomena</b> (see also 28.70.+y Nuclear explosions; 52.35.Tc Shock waves and discontinuities in plasma; 83.60.Uv—in rheology; 43.25.Cb, 43.28.Mw and 43.40.Jc—in acoustics appendix)	· · · ·	Rotational flows, see 47.32.—y	47.85.Np	Fluidics
47.40.Dc	General subsonic flows	47.55.Kf	Multiphase and particle-laden flows	<b>47.90.+a</b>	<b>Other topics in fluid dynamics</b> (restricted to new topics in section 47)
47.40.Hg	Transonic flows	47.55.Mh	Flows through porous media (for heat transfer in porous media, see 44.30.+v)		
47.40.Ki	Supersonic and hypersonic flows	<b>47.60.+i</b>	<b>Flows in ducts, channels, nozzles, and conduits</b> (see also 83.50.Ha—in rheology)		
47.40.Nm	Shock wave interactions and shock				

## 50. PHYSICS OF GASES, PLASMAS, AND ELECTRIC DISCHARGES

### 51. Physics of gases

- 51.10.+y Kinetic and transport theory of gases** (*see also 05.20.Dd Kinetic theory in classical statistical mechanics*)
- 51.20.+d Viscosity, diffusion, and thermal conductivity**
- 51.30.+i Thermodynamic properties, equations of state** (*see also 05.70.Ce Thermodynamic functions and equations of state in thermodynamics*)
- 51.35.+a Mechanical properties; compressibility**
- 51.40.+p Acoustical properties** (*see also 43.28.-g Aeroacoustics and atmospheric sound in acoustics appendix; for ultrasonic relaxation in gases, see 43.35.Fj—in acoustics appendix*)
- 51.50.+v Electrical properties (ionization, breakdown, electron and ion mobility, etc.)** (*see also 52.80.-s Electric discharges in physics of plasmas*)
- 51.60.+a Magnetic properties**
- 51.70.+f Optical and dielectric properties**
- ... Sorption, *see* 68.43.-h in surfaces and interfaces, thin films and low-dimensional structures
- ... Gas sensors and detectors, *see* 07.07.Df
- 51.90.+r Other topics in the physics of gases (restricted to new topics in section 51)**

### 52. Physics of plasmas and electric discharges (*for astrophysical plasmas, see 95.30.Qd; for physics of the ionosphere and magnetosphere, see 94.20.-y and 94.30.-d respectively*)

- 52.20.-j Elementary processes in plasmas**
- 52.20.Dq Particle orbits
- 52.20.Fs Electron collisions
- 52.20.Hv Atomic, molecular, ion, and heavy-particle collisions
- 52.25.-b Plasma properties** (*for chemical reactions in plasma, see 82.33.Xj*)
- 52.25.Dg Plasma kinetic equations
- 52.25.Fi Transport properties
- 52.25.Gj Fluctuation and chaos phenomena (*for plasma turbulence, see 52.35.Ra; see also 05.45.-a Nonlinear dynamics and nonlinear dynamical systems*)

- 52.25.Jm Ionization of plasmas
- 52.25.Kn Thermodynamics of plasmas
- 52.25.Mq Dielectric properties
- 52.25.Os Emission, absorption, and scattering of electromagnetic radiation
- 52.25.Tx Emission, absorption, and scattering of particles
- 52.25.Vy Impurities in plasmas
- 52.25.Xz Magnetized plasmas
- 52.25.Ya Neutrals in plasmas
- 52.27.-h Basic studies of specific kinds of plasmas**
- 52.27.Aj Single-component, electron-positive-ion plasmas
- 52.27.Cm Multicomponent and negative-ion plasmas
- 52.27.Ep Electron-positron plasmas
- 52.27.Gr Strongly-coupled plasmas
- 52.27.Jt Nonneutral plasmas
- 52.27.Lw Dusty or complex plasmas; plasma crystals
- 52.27.Ny Relativistic plasmas
- 52.30.-q Plasma dynamics and flow**
- 52.30.Cv Magnetohydrodynamics (including electron magnetohydrodynamics) (*see also 47.65.+a in fluid dynamics; for MHD generators, see 52.75.Fk*)
- 52.30.Ex Two-fluid and multi-fluid plasmas
- 52.30.Gz Gyrokinetics
- 52.35.-g Waves, oscillations, and instabilities in plasmas and intense beams**
- 52.35.Bj Magnetohydrodynamic waves (e.g., Alfvén waves)
- 52.35.Dm Sound waves
- 52.35.Fp Electrostatic waves and oscillations (e.g., ion-acoustic waves)
- 52.35.Hr Electromagnetic waves (e.g., electron-cyclotron, Whistler, Bernstein, upper hybrid, lower hybrid)
- 52.35.Kt Drift waves
- 52.35.Lv Other linear waves
- 52.35.Mw Nonlinear phenomena: waves, wave propagation, and other interactions (including parametric effects, mode coupling, ponderomotive effects, etc.)
- 52.35.Py Macroinstabilities (hydromagnetic, e.g., kink, fire-hose, mirror, ballooning, tearing, trapped-particle, flute, Rayleigh-Taylor, etc.)
- 52.35.Qz Microinstabilities (ion-acoustic, two-stream, loss-cone, beam-plasma, drift, ion- or electron-cyclotron, etc.)
- 52.35.Ra Plasma turbulence
- 52.35.Sb Solitons; BGK modes

- 52.35.Tc Shock waves and discontinuities
- 52.35.Vd Magnetic reconnection
- 52.35.We Plasma vorticity
- 52.38.-r Laser-plasma interactions** (*for plasma production and heating by laser beams, see 52.50.Jm*)
- 52.38.Bv Rayleigh scattering; stimulated Brillouin and Raman scattering
- 52.38.Dx Laser light absorption in plasmas (collisional, parametric, etc.)
- 52.38.Fz Laser-induced magnetic fields in plasmas
- 52.38.Hb Self-focussing, channeling, and filamentation in plasmas
- 52.38.Kd Laser-plasma acceleration of electrons and ions (*see also 41.75.Jv Laser-driven acceleration in electromagnetism; electron and ion optics*)
- 52.38.Mf Laser ablation (*see also 79.20.Ds, Laser-beam impact phenomena*)
- 52.38.Ph X-ray,  $\gamma$ -ray and particle generation
- 52.40.-w Plasma interactions (nonlaser)**
- 52.40.Db Electromagnetic (nonlaser) radiation interactions with plasma
- 52.40.Fd Plasma interactions with antennas; plasma-filled waveguides
- 52.40.Hf Plasma-material interactions; boundary layer effects
- 52.40.Kh Plasma sheaths
- 52.40.Mj Particle beam interactions in plasmas
- 52.50.-b Plasma production and heating** (*for Electric discharges, see 52.80.-s*)
- 52.50.Dg Plasma sources
- 52.50.Gj Plasma heating by particle beams
- 52.50.Jm Plasma production and heating by laser beams (laser-foil, laser-cluster, etc.)
- 52.50.Lp Plasma production and heating by shock waves and compression
- 52.50.Nr Plasma heating by DC fields; ohmic heating, arcs
- 52.50.Qt Plasma heating by radio-frequency fields; ICR, ICP, helicons
- 52.50.Sw Plasma heating by microwaves; ECR, LH, collisional heating
- 52.55.-s Magnetic confinement and equilibrium** (*see also 28.52.-s Fusion reactors*)
- 52.55.Dy General theory and basic studies of plasma lifetime, particle and heat loss, energy balance, field structure, etc.
- 52.55.Ez Theta pinch
- 52.55.Fa Tokamaks, spherical tokamaks

52.55.Hc	Stellarators, torsatrons, heliacs, bumpy tori, and other toroidal confinement devices	52.59.Qy	Wire array Z-pinchs	52.75.Hn	Plasma torches
52.55.Ip	Spheromaks	52.59.Rz	Free-electron devices ( <i>for free-electron lasers, see 41.60.Cr</i> )	52.75.Kq	Plasma switches (e.g., spark gaps)
52.55.Jd	Magnetic mirrors, gas dynamic traps	52.59.Sa	Space-charge-dominated beams	52.75.Xx	Thermionic and filament-based sources (e.g., Q machines, double- and triple-plasma devices, etc.)
52.55.Lf	Field-reversed configurations, rotamaks, astrons, ion rings, magnetized target fusion, and cusps	52.59.Tb	Moderate-intensity beams	<b>52.77.—j</b>	<b>Plasma applications</b>
52.55.Pi	Fusion products effects (e.g., alpha-particles, etc.), fast particle effects	52.59.Wd	Emittance-dominated beams	52.77.Bn	Etching and cleaning ( <i>see also 81.65.Cf Surface cleaning, etching, patterning in surface treatments</i> )
52.55.Rk	Power exhaust; divertors	52.59.Ye	Plasma devices for generation of coherent radiation	52.77.Dq	Plasma-based ion implantation and deposition ( <i>see also 81.15.Jj Ion and electron beam-assisted deposition</i> )
52.55.Tn	Ideal and resistive MHD modes; kinetic modes	<b>52.65.—y</b>	<b>Plasma simulation</b>	52.77.Fv	High-pressure, high-current plasmas (plasma spray, arc welding, etc.) ( <i>see also 81.15.Rs Spray coating techniques</i> )
52.55.Wq	Current drive; helicity injection	52.65.Cc	Particle orbit and trajectory	. . . .	<i>Chemical synthesis; combustion synthesis, see 81.20.Ka</i>
<b>52.57.—z</b>	<b>Laser inertial confinement</b>	52.65.Ff	Fokker-Planck and Vlasov equation	<b>52.80.—s</b>	<b>Electric discharges</b> ( <i>see also 51.50.+v Electrical properties of gases; for plasma reactions including flowing afterglow and electric discharges, see 82.33.Xj in physical chemistry and chemical physics</i> )
52.57.Bc	Target design and fabrication	52.65.Kj	Magnetohydrodynamic and fluid equation	52.80.Dy	Low-field and Townsend discharges
52.57.Fg	Implosion symmetry and hydrodynamic instability (Rayleigh-Taylor, Richtmyer-Meshkov, imprint, etc.)	52.65.Pp	Monte Carlo methods	52.80.Hc	Glow; corona
52.57.Kk	Fast ignition of compressed fusion fuels	52.65.Rr	Particle-in-cell method	52.80.Mg	Arcs; sparks; lightning; atmospheric electricity ( <i>see also 92.60.Pw in hydrospheric and atomospheric geophysics</i> )
<b>52.58.—c</b>	<b>Other confinement methods</b>	52.65.Tt	Gyrofluid and gyrokinetic simulations	52.80.Pi	High-frequency and RF discharges
52.58.Ei	Light-ion inertial confinement	52.65.Vv	Perturbative methods	52.80.Qj	Explosions; exploding wires
52.58.Hm	Heavy-ion inertial confinement	52.65.Ww	Hybrid methods	52.80.Sm	Magnetoactive discharges (e.g., Penning discharges)
52.58.Lq	Z-pinchs, plasma focus and other pinch devices	52.65.Yy	Molecular dynamics methods	52.80.Tn	Other gas discharges
52.58.Qv	Electrostatic and high-frequency confinement	<b>52.70.—m</b>	<b>Plasma diagnostic techniques and instrumentation</b>	52.80.Vp	Discharge in vacuum
<b>52.59.—f</b>	<b>Intense particle beams and radiation sources</b> ( <i>see also 29.25.—t and 29.27.—a in instrumentation for particle and nuclear physics</i> )	52.70.Ds	Electric and magnetic measurements	52.80.Wq	Discharge in liquids and solids ( <i>for electric breakdown in liquids, see 77.22.Jp</i> )
52.59.Bi	Grid- and ion-diode-accelerated beams	52.70.Gw	Radio-frequency and microwave measurements	52.80.Yr	Discharges for spectral sources (including inductively coupled plasma)
52.59.Dk	Magneto-plasma accelerated plasmas	52.70.Kz	Optical (ultraviolet, visible, infrared) measurements	<b>52.90.+z</b>	<b>Other topics in physics of plasmas and electric discharges (restricted to new topics in section 52)</b>
52.59.Fn	Multistage accelerated heavy-ion beams	52.70.La	X-ray and $\gamma$ -ray measurements		
52.59.Hq	Dense plasma focus	52.70.Nc	Particle measurements		
52.59.Mv	High-voltage diodes ( <i>for high-current and high-voltage technology, see 84.70.+p</i> )	<b>52.72.+v</b>	<b>Laboratory studies of space- and astrophysical-plasma processes</b> ( <i>see also 95.30.Qd in fundamental aspects of astrophysics and 94.20.—y and 94.30.—d in aeronomy and magnetospheric physics</i> )		
52.59.Px	Hard X-ray sources	<b>52.75.—d</b>	<b>Plasma devices</b> ( <i>for ion sources, see 29.25.Lg, Ni; for plasma sources, see 52.50.Dg</i> )		
		52.75.Di	Ion and plasma propulsion		
		52.75.Fk	Magnetohydrodynamic generators and thermionic convertors; plasma diodes ( <i>see also 84.60.Lw, Ny in direct-energy conversion and storage</i> )		



## 60. CONDENSED MATTER: STRUCTURAL, MECHANICAL AND THERMAL PROPERTIES

### 61. Structure of solids and liquids; crystallography *(for surface, interface, and thin film structure, see section 68)*

- 61.10.—i X-ray diffraction and scattering** *(for x-ray diffractometers, see 07.85.Jy; for x-ray studies of crystal defects, see 61.72.Dd, Ff)*
- 61.10.Dp Theories of diffraction and scattering
- 61.10.Eq X-ray scattering (including small-angle scattering)
- 61.10.Ht X-ray absorption spectroscopy: EXAFS, NEXAFS, XANES, etc.
- 61.10.Kw X-ray reflectometry (surfaces, interfaces, films)
- 61.10.Nz X-ray diffraction
- 61.12.—q Neutron diffraction and scattering**
- 61.12.Bt Theories of diffraction and scattering
- 61.12.Ex Neutron scattering (including small-angle scattering)
- 61.12.Ha Neutron reflectometry
- 61.12.Ld Neutron diffraction
- 61.14.—x Electron diffraction and scattering** *(for electron diffractometers, see 07.78.+s)*
- 61.14.Dc Theories of diffraction and scattering
- 61.14.Hg Low-energy electron diffraction (LEED) and reflection high-energy electron diffraction (RHEED)
- 61.14.Lj Convergent-beam electron diffraction, selected-area electron diffraction, nanodiffraction
- 61.14.Nm Electron holography
- 61.14.Qp X-ray photoelectron diffraction
- ... *Microscopy of surfaces, interfaces, and thin films, see 68.37.—d*
- 61.18.—j Other methods of structure determination**
- 61.18.Bn Atom, molecule, and ion scattering
- 61.18.Fs Magnetic resonance techniques; Mössbauer spectroscopy
- 61.20.—p Structure of liquids**
- 61.20.Gy Theory and models of liquid structure
- 61.20.Ja Computer simulation of liquid structure
- 61.20.Lc Time-dependent properties; relaxation *(for glass transitions, see 64.70.Pf)*
- 61.20.Ne Structure of simple liquids
- 61.20.Qg Structure of associated liquids: electrolytes, molten salts, etc.
- 61.25.—f Studies of specific liquid structures**

- 61.25.Bi Liquid noble gases
- 61.25.Em Molecular liquids
- 61.25.Hq Macromolecular and polymer solutions; polymer melts; swelling
- 61.25.Mv Liquid metals and alloys
- 61.30.—v Liquid crystals** *(for phase transitions in liquid crystals, see 64.70.Md; for liquid crystals as dielectric materials, see 77.84.Nh; for liquid crystals as optical materials, see 42.70.Df; for liquid crystal devices, see 42.79.Kt)*
- 61.30.Cz Molecular and microscopic models and theories of liquid crystal structure
- 61.30.Dk Continuum models and theories of liquid crystal structure
- 61.30.Eb Experimental determinations of smectic, nematic, cholesteric, and other structures
- 61.30.Gd Orientational order of liquid crystals; electric and magnetic field effects on order
- 61.30.Hn Surface phenomena: alignment, anchoring, anchoring transitions, surface-induced layering, surface-induced ordering, wetting, prewetting transitions, and wetting transitions *(see also section 68 Surfaces and interfaces; thin films and low-dimensional systems)*
- 61.30.Jf Defects in liquid crystals
- 61.30.Mp Blue phases and other defect-phases
- 61.30.Pq Microconfined liquid crystals: droplets, cylinders, randomly confined liquid crystals, polymer dispersed liquid crystals, and porous systems
- 61.30.St Lyotropic phases
- 61.30.Vx Polymer liquid crystals
- 61.41.—e Polymers, elastomers, and plastics** *(see also 81.05.Lg in materials science; for rheology of polymers, see section 83; for polymer reactions and polymerization, see 82.35.—x in physical chemistry and chemical physics)*
- 61.43.—j Disordered solids** *(see also 81.05.Gc, 81.05.Kf, and 81.05.Rm in materials science; for photoluminescence of disordered solids, see 78.55.Mb and 78.55.Qr)*
- 61.43.Bn Structural modeling: serial-addition models, computer simulation
- 61.43.Dq Amorphous semiconductors, metals, and alloys
- 61.43.Er Other amorphous solids
- 61.43.Fs Glasses
- 61.43.Gt Powders, porous materials

- 61.43.Hv Fractals; macroscopic aggregates (including diffusion-limited aggregates)
- 61.44.—n Semi-periodic solids**
- 61.44.Br Quasicrystals
- 61.44.Fw Incommensurate crystals
- 61.46.—w Nanoscale materials: clusters, nanoparticles, nanotubes, and nanocrystals** *(see also 36.40.—c Atomic and molecular clusters; for fabrication and characterization of nanoscale materials, see 81.07.—b in materials science)*
- 61.48.—c Fullerenes and fullerene-related materials** *(see also 81.05.Tp Fullerenes and related materials in materials science)*
- 61.50.—f Crystalline state**
- 61.50.Ah Theory of crystal structure, crystal symmetry; calculations and modeling
- ... *Crystal growth, see 81.10.—h*
- 61.50.Ks Crystallographic aspects of phase transformations; pressure effects *(see also 81.30.Hd in materials science)*
- 61.50.Lt Crystal binding; cohesive energy
- 61.50.Nw Crystal stoichiometry
- 61.66.—f Structure of specific crystalline solids** *(for surface structure, see 68.35.Bs)*
- 61.66.Bi Elemental solids
- 61.66.Dk Alloys
- 61.66.Fn Inorganic compounds
- 61.66.Hq Organic compounds
- ... *Quantum crystals, see 67.80.Cx*
- 61.68.—n Crystallographic databases**
- 61.72.—y Defects and impurities in crystals; microstructure** *(for radiation induced defects, see 61.80.—x; for defects in surfaces, interfaces and thin films, see 68.35.Dv and 68.55.Ln; see also 85.40.Ry Impurity doping, diffusion and ion implantation technology)*
- 61.72.Bb Theories and models of crystal defects
- 61.72.Cc Kinetics of defect formation and annealing
- 61.72.Dd Experimental determination of defects by diffraction and scattering
- 61.72.Ff Direct observation of dislocations and other defects (etch pits, decoration, electron microscopy, x-ray topography, etc.)
- 61.72.Hh Indirect evidence of dislocations and other defects (resistivity, slip, creep, strains, internal friction, EPR, NMR, etc.)

61.72.Ji	Point defects (vacancies, interstitials, color centers, etc.) and defect clusters	(for nonlinear acoustics of solids, see 43.25.Dc—in acoustics appendix; for mechanical and acoustical properties of interfaces and thin films, see 68.35.Gy, 68.35.Iv, and 68.60.Bs; for mechanical properties related to treatment conditions, see 81.40.Jj, Lm, Np—in material science; for mechanical and acoustical properties of superconductors, see 74.25.Ld; for mechanical properties of rocks and minerals, see 91.60.−x)	· · · · Magnetoacoustic effects, see 72.55.+s and 73.50.Rb
61.72.Lk	Linear defects: dislocations, disclinations		· · · · Acoustoelectric effects, see 72.50.+b, 73.50.Rb, and 77.65.Dq
61.72.Mm	Grain and twin boundaries		· · · · Acoustooptical effects, see 78.20.Hp
61.72.Nn	Stacking faults and other planar or extended defects		<b>62.80.+f Ultrasonic relaxation</b> (see also 43.35.Fj Ultrasonic relaxation processes in liquids and solids—in acoustics appendix; for ultrasonic attenuation in superconductors, see 74.25.Ld)
61.72.Qq	Microscopic defects (voids, inclusions, etc.)		<b>62.90.+k Other topics in mechanical and acoustical properties of condensed matter</b> (restricted to new topics in section 62)
61.72.Ss	Impurity concentration, distribution, and gradients (for impurities in thin films, see 68.55.Ln; see also 66.30.Jt Diffusion of impurities)		
61.72.Tt	Doping and impurity implantation in germanium and silicon	<b>62.10.+s Mechanical properties of liquids</b> (for viscosity of liquids, see 66.20.−x)	
61.72.Vv	Doping and impurity implantation in III–V and II–VI semiconductors	<b>62.20.−x Mechanical properties of solids</b>	
61.72.Ww	Doping and impurity implantation in other materials	62.20.Dc Elasticity, elastic constants	<b>63. Lattice dynamics</b> (see also 78.30.−j Infrared and Raman spectra; for surface and interface vibrations, see 68.35.Ja; for adsorbate vibrations, see 68.43.Pq)
61.72.Yx	Interaction between different crystal defects; gettering effect	62.20.Fe Deformation and plasticity (including yield, ductility, and superplasticity) (see also 83.50.−v Deformation and flow in rheology)	<b>63.10.+a General theory</b>
<b>61.80.−x Physical radiation effects, radiation damage (for photochemical reactions, see 82.50.−m)</b>		62.20.Hg Creep	<b>63.20.−e Phonons in crystal lattices</b> (for phonons in superconductors, see 74.25.Kc; see also 43.35.Gk Phonons in crystal lattice, quantum acoustics—in acoustics appendix)
· · · · Radiation treatments, see 81.40.Wx		62.20.Mk Fatigue, brittleness, fracture, and cracks	63.20.Dj Phonon states and bands, normal modes, and phonon dispersion
61.80.Az	Theory and models of radiation effects	62.20.Qp Tribology and hardness (see also 46.55.+d Tribology and mechanical contacts in continuum mechanics of solids)	63.20.Kr Phonon–electron and phonon–phonon interactions
61.80.Ba	Ultraviolet, visible, and infrared radiation effects (including laser radiation)	<b>62.25.+g Mechanical properties of nanoscale materials</b>	63.20.Ls Phonon interactions with other quasiparticles
61.80.Cb	X-ray effects	<b>62.30.+d Mechanical and elastic waves; vibrations</b> (see also 43.40.+s Structural acoustics and vibration; 46.40.−f Vibrations and mechanical waves in continuum mechanics of solids)	63.20.Mt Phonon–defect interactions
61.80.Ed	γ-ray effects	<b>62.40.+i Anelasticity, internal friction, stress relaxation, and mechanical resonances</b> (see also 81.40.Jj Elasticity and anelasticity)	63.20.Pw Localized modes
61.80.Fe	Electrons and positron radiation effects	· · · · Thermomechanical effects, see 65.40.De	63.20.Ry Anharmonic lattice modes
61.80.Hg	Neutron radiation effects	· · · · Magnetomechanical effects, see 75.80.+q	<b>63.22.+m Phonons or vibrational states in low-dimensional structures and nanoscale materials</b>
61.80.Jh	Ion radiation effects (for ion implantation, see 61.72.Tt, Vv, Ww)	· · · · Piezoelectric effects, see 77.65.−j	<b>63.50.+x Vibrational states in disordered systems</b>
61.80.Lj	Atom and molecule irradiation effects	· · · · Elastooptical effects, see 78.20.Hp	<b>63.70.+h Statistical mechanics of lattice vibrations and displacive phase transitions</b>
· · · · Channeling, blocking, and energy loss of particles, see 61.85.+p		<b>62.50.+p High-pressure and shock wave effects in solids and liquids</b> (for high pressure apparatus and techniques, see 07.35.+k; for shock wave initiated high-pressure chemistry, see 82.40.Fp)	<b>63.90.+t Other topics in lattice dynamics</b> (restricted to new topics in section 63)
<b>61.82.−d Radiation effects on specific materials</b>		<b>62.60.+v Acoustical properties of liquids</b> (see also 43.35.+d in acoustics)	<b>64. Equations of state, phase equilibria, and phase transitions</b> (see also 82.60.−s Chemical thermodynamics)
61.82.Bg	Metals and alloys	· · · · Lattice dynamics, phonons, see section 63	<b>64.10.+h General theory of equations of state and phase equilibria</b> (see also 05.70.Ce Thermodynamic functions and equations of state in thermodynamics)
61.82.Fk	Semiconductors	· · · · Second sound in quantum fluids, see 67.40.Pm	
61.82.Ms	Insulators	<b>62.65.+k Acoustical properties of solids</b>	
61.82.Pv	Polymers, organic compounds		
61.82.Rx	Nanocrystalline materials		
<b>61.85.+p Channeling phenomena (blocking, energy loss, etc.)</b>			
<b>61.90.+d Other topics in structure of solids and liquids</b> (restricted to new topics in section 61)			
<b>62. Mechanical and acoustical properties of condensed matter</b>			

64.30.+t	Equations of state of specific substances	condensed matter (see also 05.70. –a Thermodynamics and section 44 Heat transfer; for thermodynamic properties of quantum fluids and solids, see section 67; for thermal properties of thin films, see 68.60.Dv; for nonelectronic thermal conduction, see 66.60. +a and 66.70. +f; for thermal properties of rocks and minerals, see 91.60.Ki; for thermodynamic properties of superconductors, see 74.25.Bt)	66.30.Ny	Chemical interdiffusion; diffusion barriers	
64.60.–i	General studies of phase transitions (see also 63.70. +h Statistical mechanics of lattice vibrations and displacive phase transitions; for critical phenomena in solid surfaces and interfaces, and in magnetism, see 68.35.Rh, and 75.40. –s, respectively)		66.30.Pa	Diffusion in nanoscale solids	
64.60.Ak	Renormalization-group, fractal, and percolation studies of phase transitions (see also 61.43.Hv Fractals; macroscopic aggregates)		66.30.Qa	Electromigration	
64.60.Cn	Order–disorder transformations; statistical mechanics of model systems		66.30.Xj	Thermal diffusivity	
64.60.Fr	Equilibrium properties near critical points, critical exponents		66.35.+a	Quantum tunneling of defects	
64.60.Ht	Dynamic critical phenomena		66.60.+a	Thermal conduction in nonmetallic liquids (for thermal conduction in liquid metals, see 72.15.Cz)	
64.60.Kw	Multicritical points		66.70.+f	Nonelectronic thermal conduction and heat-pulse propagation in solids; thermal waves (for thermal conduction in metals and alloys, see 72.15.Cz and 72.15.Eb)	
64.60.My	Metastable phases		66.90.+r	Other topics in nonelectronic transport properties of condensed matter (restricted to new topics in section 66)	
64.60.Qb	Nucleation (see also 82.60.Nh Thermodynamics of nucleation in physical chemistry and chemical physics)		67. Quantum fluids and solids; liquid and solid helium (see also 05.30. –d Quantum statistical mechanics)	67.20.+k	Quantum effects on the structure and dynamics of nondegenerate fluids (e.g., normal phase liquid <sup>4</sup> He)
64.70.–p	Specific phase transitions			67.40.–w	Boson degeneracy and superfluidity of <sup>4</sup> He
64.70.Dv	Solid–liquid transitions	67.40.Bz		Phenomenology and two-fluid models	
64.70.Fx	Liquid–vapor transitions	67.40.Db		Quantum statistical theory; ground state, elementary excitations	
64.70.Hz	Solid–vapor transitions	67.40.Fd		Dynamics of relaxation phenomena	
64.70.Ja	Liquid–liquid transitions	67.40.Hf		Hydrodynamics in specific geometries, flow in narrow channels	
64.70.Kb	Solid–solid transitions (see also 61.50.Ks Crystallographic aspects of phase transformations; pressure effects; 75.30.Kz and 77.80.Bh for magnetic and ferroelectric transitions, respectively; for material science aspects, see 81.30. –t)	67.40.Jg		Ions in liquid <sup>4</sup> He	
64.70.Md	Transitions in liquid crystals	67.40.Kh		Thermodynamic properties	
64.70.Nd	Structural transitions in nanoscale materials	67.40.Mj		First sound	
64.70.Pf	Glass transitions	67.40.Pm		Transport processes, second and other sounds, and thermal counterflow; Kapitza resistance	
64.70.Rh	Commensurate–incommensurate transitions	67.40.Rp	Films and weak link transport		
64.75.+g	Solubility, segregation, and mixing; phase separation (see also 82.60.Lf Thermodynamics of solutions)	67.40.Vs	Vortices and turbulence		
64.90.+b	Other topics in equations of state, phase equilibria, and phase transitions (restricted to new topics in section 64)	67.40.Yv	Impurities and other defects		
65. Thermal properties of		66.10.–x	Diffusion and ionic conduction in liquids	67.55.–s	Normal phase of liquid <sup>3</sup> He
		66.10.Cb	Diffusion and thermal diffusion (for osmosis in biological systems, see 82.39.Wj)	67.55.Cx	Thermodynamic properties
		66.10.Ed	Ionic conduction	67.55.Fa	Hydrodynamics
		66.20.+d	Viscosity of liquids; diffusive momentum transport	67.55.Hc	Transport properties
		66.30.–h	Diffusion in solids (for surface and interface diffusion, see 68.35.Fx)	67.55.Ig	Ions in normal liquid <sup>3</sup> He
		66.30.Dn	Theory of diffusion and ionic conduction in solids	67.55.Jd	Collective modes
		66.30.Fq	Self-diffusion in metals, semimetals, and alloys	67.55.Lf	Impurities
		66.30.Hs	Self-diffusion and ionic conduction in nonmetals	67.57.–z	Superfluid phase of liquid <sup>3</sup> He
		66.30.Jt	Diffusion of impurities	67.57.Bc	Thermodynamic properties
		66.30.Lw	Diffusion of other defects	67.57.De	Superflow and hydrodynamics
		67.57.Fg	Textures and vortices	67.57.Gh	Ions in superfluid <sup>3</sup> He

67.57.Hi	Transport properties	68.18.Fg	Structure: measurements and simulations		structure and reactions ( <i>for electronic structure of adsorbates, see 73.20.Hb; for adsorbate reactions, see also 82.65.+r Surface and interface chemistry; heterogeneous catalysis at surfaces</i> )
67.57.Jj	Collective modes	68.18.Jk	Phase transitions		
67.57.Lm	Spin dynamics	<b>68.35.—p</b>	<b>Solid surfaces and solid–solid interfaces: Structure and energetics</b>		
67.57.Np	Behavior near interfaces	68.35.Af	Atomic scale friction	68.43.De	Statistical mechanics of adsorbates
67.57.Pq	Impurities	68.35.Bs	Structure of clean surfaces (reconstruction)	68.43.Fg	Adsorbate structure (binding sites, geometry)
<b>67.60.—g</b>	<b>Mixed systems; liquid <math>^3\text{He}</math>, <math>^4\text{He}</math> mixtures</b>	68.35.Ct	Interface structure and roughness	68.43.Hn	Structure of assemblies of adsorbates (two- and three-dimensional clustering)
67.60.Dm	He I— $^3\text{He}$	68.35.Dv	Composition, segregation; defects and impurities	68.43.Jk	Diffusion of adsorbates, kinetics of coarsening and aggregation
67.60.Fp	He II— $^3\text{He}$	68.35.Fx	Diffusion; interface formation ( <i>see also 66.30.—h Diffusion in solids, for diffusion of adsorbates, see 68.43.Jk</i> )	68.43.Mn	Adsorption/desorption kinetics
67.60.Hr	Dilute superfluid $^3\text{He}$ in He II	68.35.Gy	Mechanical properties; surface strains	68.43.Pq	Adsorbate vibrations
67.60.Js	Ions in liquid $^3\text{He}$ — $^4\text{He}$ mixtures	68.35.Iv	Acoustical properties	68.43.Rs	Electron stimulated desorption
<b>67.65.+z</b>	<b>Spin-polarized hydrogen and helium</b>	68.35.Ja	Surface and interface dynamics and vibrations	68.43.Tj	Photon stimulated desorption
<b>67.70.+n</b>	<b>Films (including physical adsorption)</b>	. . . .	<i>Solid-solid interfaces: transport and optical properties, see 73.40.—c and 78.20.—e respectively</i>	68.43.Vx	Thermal desorption
<b>67.80.—s</b>	<b>Solid helium and related quantum crystals</b>	68.35.Md	Surface thermodynamics, surface energies ( <i>see also 05.70.Np Interface and surface thermodynamics in statistical physics, thermodynamics and nonlinear dynamical systems</i> )	<b>68.47.—b</b>	<b>Solid–gas/vacuum interfaces: types of surfaces</b>
67.80.Cx	Structure, lattice dynamics, and sound propagation	68.35.Np	Adhesion ( <i>for polymer adhesion, see 82.35.Gh</i> )	68.47.De	Metallic surfaces
67.80.Gb	Thermal properties	68.35.Rh	Phase transitions and critical phenomena	68.47.Fg	Semiconductor surfaces
67.80.Jd	Magnetic properties and nuclear magnetic resonance	<b>68.37.—d</b>	<b>Microscopy of surfaces, interfaces, and thin films</b>	68.47.Gh	Oxide surfaces
67.80.Mg	Defects, impurities, and diffusion	68.37.Ef	Scanning tunneling microscopy (including chemistry induced with STM)	68.47.Jn	Clusters on oxide surfaces
<b>67.90.+z</b>	<b>Other topics in quantum fluids and solids; liquid and solid helium (restricted to new topics in section 67)</b>	68.37.Hk	Scanning electron microscopy (SEM) (including EBIC)	68.47.Mn	Polymer surfaces
<b>68. Surfaces and interfaces; thin films and low-dimensional systems (structure and nonelectronic properties)</b> ( <i>for surface and interface chemistry, see 82.65.+r; for surface magnetism, see 75.70.Rf</i> )		68.37.Lp	Transmission electron microscopy (TEM) (including STEM, HRTEM, etc.)	68.47.Pe	Langmuir–Blodgett films on solids; polymers on surfaces; biological molecules on surfaces
<b>68.03.—g</b>	<b>Gas-liquid and vacuum-liquid interfaces</b>	68.37.Nq	Low energy electron microscopy (LEEM)	<b>68.49.—h</b>	<b>Surface characterization by particle–surface scattering</b> ( <i>see also 34.50.Dy Interactions of atoms and molecules with surfaces; photon and electron emission; neutralization of ions in atomic and molecular collision processes and interactions</i> )
68.03.Cd	Surface tension and related phenomena	68.37.Ps	Atomic force microscopy (AFM)	68.49.Bc	Atom scattering from surfaces (diffraction and energy transfer)
68.03.Fg	Evaporation and condensation	68.37.Rt	Magnetic force microscopy (MFM)	68.49.Df	Molecule scattering from surfaces (energy transfer, resonances, trapping)
68.03.Hj	Structure, measurements and simulations	68.37.Tj	Acoustic force microscopy	68.49.Fg	Cluster scattering from surfaces
68.03.Kn	Dynamics (capillary waves)	68.37.Uv	Near-field scanning microscopy and spectroscopy	68.49.Jk	Electron scattering from surfaces
<b>68.05.—n</b>	<b>Liquid-liquid interfaces</b>	68.37.Vj	Field emission and field-ion microscopy	68.49.Sf	Ion scattering from surfaces (charge transfer, sputtering, SIMS)
68.05.Cf	Structure, measurements and simulations	68.37.Xy	Scanning Auger microscopy, photoelectron microscopy	68.49.Uv	X-ray standing waves
68.05.Gh	Interfacial properties of microemulsions	68.37.Yz	X-ray microscopy	. . . .	<i>Surface and interface electron states, see 73.20.—r</i>
<b>68.08.—p</b>	<b>Liquid-solid interfaces</b>	<b>68.43.—h</b>	<b>Chemisorption/physisorption: adsorbates on surfaces</b>	. . . .	<i>Electronic structure of adsorbates, see 73.20.Hb</i>
68.08.Bc	Wetting	68.43.Bc	Ab initio calculations of adsorbate	. . . .	<i>Vibrational spectroscopy (IR, Raman, ATR), see 78.30.—j</i>
68.08.De	Structure, measurements and simulations			. . . .	<i>Electron spectroscopy (EELS, Auger, metastable quenching spectroscopy see 79.20.—m</i>
. . . .	<i>Crystal growth, biomineralization, see 81.10.Dn, Fq</i>			. . . .	<i>Photoelectron spectroscopy (XPS and UPS), see 79.60.—i</i>
<b>68.15.+e</b>	<b>Liquid thin films</b>			. . . .	<i>Nonlinear spectroscopy (second harmonic, sum frequency generation, etc.), see 42.65.Ky</i>
<b>68.18.—g</b>	<b>Langmuir–Blodgett films on liquids</b> ( <i>for L-B films on solids, see 68.47.Pe</i> )			. . . .	<i>Electron diffraction (LEED, RHEED), see 61.14.—x</i>



· · · ·	<i>Surface enhanced spectroscopy, plasmons, see 73.20.Mf</i>	<b>68.60.—p</b>	<b>Physical properties of thin films, nonelectronic</b>	68.65.Ac	Multilayers
· · · ·	<i>Near-field scanning microscopy and spectroscopy, see 68.37.Uv</i>	68.60.Bs	Mechanical and acoustical properties	68.65.Cd	Superlattices
<b>68.55.—a</b>	<b>Thin film structure and morphology</b> ( <i>for methods of thin film deposition, film growth and epitaxy, see 81.15.—z</i> )	68.60.Dv	Thermal stability; thermal effects	68.65.Fg	Quantum wells
68.55.Ac	Nucleation and growth: microscopic aspects	68.60.Wm	Other nonelectronic physical properties	68.65.Hb	Quantum dots
68.55.Jk	Structure and morphology; thickness; crystalline orientation and texture	<b>68.65.—k</b>	<b>Low-dimensional, mesoscopic, and nanoscale systems: structure and nonelectronic properties</b> ( <i>for structure of nanoscale materials, see 61.46.+w; for magnetic properties of interfaces, see 75.70.Cn; for superconducting properties, see 74.78.—w; for optical properties, see 78.67.—n; for transport properties, see 73.63.—b</i> )	68.65.La	Quantum wires
68.55.Ln	Defects and impurities: doping, implantation, distribution, concentration, etc. ( <i>for diffusion of impurities, see 66.30.Jt</i> )	· · · ·	<i>Growth of low-dimensional structures, see 81.16.—c</i>	<b>68.70.+w</b>	<b>Whiskers and dendrites (growth, structure, and nonelectronic properties)</b>
68.55.Nq	Composition and phase identification			<b>68.90.+g</b>	<b>Other topics in structure, and nonelectronic properties of surfaces and interfaces; thin films and low-dimensional structures (restricted to new topics in section 68)</b>

## 70. CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES

### 71. Electronic structure of bulk materials (*see section 73 for electronic structure of surfaces, interfaces, low-dimensional structures, and nanomaterials; for electronic structure of superconductors, see 74.25.Jb*)

#### 71.10.—w Theories and models of many-electron systems

- 71.10.Ay Fermi-liquid theory and other phenomenological models
- 71.10.Ca Electron gas, Fermi gas
- 71.10.Fd Lattice fermion models (Hubbard model, etc.)
- 71.10.Hf Non-Fermi-liquid ground states, electron phase diagrams and phase transitions in model systems
- 71.10.Li Excited states and pairing interactions in model systems
- 71.10.Pm Fermions in reduced dimensions (anyons, composite fermions, Luttinger liquid, etc.) (*for anyon mechanism in superconductors, see 74.20.Mn*)

#### 71.15.—m Methods of electronic structure calculations (*see also 31.15.—p Calculations and mathematical techniques in atomic and molecular physics*)

- 71.15.Ap Basis sets (LCAO, plane-wave, APW, etc.) and related methodology (scattering methods, ASA, linearized methods, etc.)
- 71.15.Dx Computational methodology (Brillouin zone sampling, iterative diagonalization, pseudopotential construction)
- 71.15.Mb Density functional theory, local density approximation, gradient and other corrections
- 71.15.Nc Total energy and cohesive energy calculations
- 71.15.Pd Molecular dynamics calculations (Car–Parrinello) and other numerical simulations
- 71.15.Qe Excited states: methodology (*see also 71.10.Li Excited states and pairing interactions in model systems*)
- 71.15.Rf Relativistic effects

#### 71.18.—y Fermi surface: calculations and measurements; effective mass, g factor

- 71.20.—b Electron density of states and band structure of crystalline solids (*for electronic structure of superconductors, see 74.25.Jb*)
- 71.20.Be Transition metals and alloys
- 71.20.Dg Alkali and alkaline earth metals

- 71.20.Eh Rare earth metals and alloys
- 71.20.Gj Other metals and alloys
- 71.20.Lp Intermetallic compounds
- 71.20.Mq Elemental semiconductors
- 71.20.Nr Semiconductor compounds
- 71.20.Ps Other inorganic compounds
- 71.20.Rv Polymers and organic compounds
- 71.20.Tx Fullerenes and related materials; intercalation compounds
- . . . . Photonic band-gap materials, *see 42.70.Qs*

#### 71.22.—i Electronic structure of liquid metals and semiconductors and their alloys

#### 71.23.—k Electronic structure of disordered solids

- 71.23.An Theories and models; localized states
- 71.23.Cq Amorphous semiconductors, metallic glasses, glasses
- 71.23.Ft Quasicrystals

#### 71.27.—a Strongly correlated electron systems; heavy fermions

#### 71.28.—d Narrow-band systems; intermediate-valence solids (*for magnetic aspects, see 75.20.Hr and 75.30.Mb in magnetic properties and materials*)

#### 71.30.—h Metal–insulator transitions and other electronic transitions

#### 71.35.—y Excitons and related phenomena

- 71.35.Aa Frenkel excitons and self-trapped excitons
- 71.35.Cc Intrinsic properties of excitons; optical absorption spectra
- 71.35.Ee Electron-hole drops and electron-hole plasma
- 71.35.Gg Exciton-mediated interactions
- 71.35.Ji Excitons in magnetic fields; magnetoexcitons
- 71.35.Lk Collective effects (Bose effects, phase space filling, and excitonic phase transitions)
- 71.35.Pq Charged excitons (trions)

#### 71.36.—c Polaritons (including photon–phonon and photon–magnon interactions)

#### 71.38.—k Polarons and electron-phonon interactions (*see also 63.20.Kr Phonon-electron interactions in lattices*)

- 71.38.Cn Mass renormalization in metals
- 71.38.Fp Large or Fröhlich polarons
- 71.38.Ht Self-trapped or small polarons
- 71.38.Mx Bipolarons

#### 71.45.—d Collective effects

- 71.45.Gm Exchange, correlation, dielectric and magnetic response functions, plasmons
- 71.45.Lr Charge-density-wave systems (*see also 75.30.Fv Spin-density waves*)

#### 71.55.—i Impurity and defect levels

- 71.55.Ak Metals, semimetals, and alloys
- 71.55.Cn Elemental semiconductors
- 71.55.Eq III–V semiconductors
- 71.55.Gs II–VI semiconductors
- 71.55.Ht Other nonmetals
- 71.55.Jv Disordered structures; amorphous and glassy solids

#### 71.60.—z Positron states (*for positron annihilation, see 78.70.Bj*)

#### 71.70.—d Level splitting and interactions (*see also 73.20.—r Surface and interface electron states; 75.30.Et Exchange and superexchange interactions*)

- 71.70.Ch Crystal and ligand fields
- 71.70.Di Landau levels
- 71.70.Ej Spin–orbit coupling, Zeeman and Stark splitting, Jahn–Teller effect
- 71.70.Fk Strain-induced splitting
- 71.70.Gm Exchange interactions
- 71.70.Jp Nuclear states and interactions

#### 71.90.—q Other topics in electronic structure (restricted to new topics in section 71)

### 72. Electronic transport in condensed matter (*for electronic transport in surfaces, interfaces, and thin films, see section 73; for electrical properties related to treatment conditions, see 81.40.Rs; for transport properties of superconductors, see 74.25.Fy*)

#### 72.10.—d Theory of electronic transport; scattering mechanisms

- 72.10.Bg General formulation of transport theory
- 72.10.Di Scattering by phonons, magnons, and other nonlocalized excitations (*see also 71.45.—d Collective effects in electronic structure of bulk materials*)
- 72.10.Fk Scattering by point defects, dislocations, surfaces, and other imperfections (including Kondo effect)

#### 72.15.—v Electronic conduction in metals and alloys

72.15.Cz	Electrical and thermal conduction in amorphous and liquid metals and alloys	72.55.+s	<b>Magnetoacoustic effects</b> ( <i>see also</i> 75.80.+q <i>Magnetomechanical and magnetoelectric effects, magnetostriction</i> )	73.21.Fg	Quantum wells
72.15.Eb	Electrical and thermal conduction in crystalline metals and alloys	72.60.+g	<b>Mixed conductivity and conductivity transitions</b>	73.21.Hb	Quantum wires
72.15.Gd	Galvanomagnetic and other magnetotransport effects ( <i>see also</i> 75.47.-m <i>Magnetotransport phenomena; materials for magnetotransport</i> )	72.70.+m	<b>Noise processes and phenomena</b>	73.21.La	Quantum dots
72.15.Jf	Thermoelectric and thermomagnetic effects	72.80.-r	<b>Conductivity of specific materials</b> ( <i>for conductivity of metals and alloys, see</i> 72.15.-v)	73.22.-f	<b>Electronic structure of nanoscale materials: clusters, nanoparticles, nanotubes, and nanocrystals</b>
72.15.Lh	Relaxation times and mean free paths	72.80.Cw	Elemental semiconductors	73.22.Dj	Single particle states
72.15.Nj	Collective modes (e.g., in one-dimensional conductors)	72.80.Ey	III-V and II-VI semiconductors	73.22.Gk	Broken symmetry phases
72.15.Qm	Scattering mechanisms and Kondo effect ( <i>see also</i> 75.20.Hr <i>Local moments in compounds and alloys; Kondo effect, valence fluctuations, heavy fermions in magnetic properties and materials</i> )	72.80.Ga	Transition-metal compounds	73.22.Lp	Collective excitations
72.15.Rn	Localization effects (Anderson or weak localization)	72.80.Jc	Other crystalline inorganic semiconductors	73.23.-b	<b>Electronic transport in mesoscopic systems</b>
72.20.-i	<b>Conductivity phenomena in semiconductors and insulators</b> ( <i>see also</i> 66.70.+f <i>Nonelectronic thermal conduction in solids</i> )	72.80.Le	Polymers; organic compounds (including organic semiconductors)	73.23.Ad	Ballistic transport ( <i>see also</i> 75.47.Jn <i>Ballistic magnetoresistance in magnetic properties and materials</i> )
72.20.Dp	General theory, scattering mechanisms	72.80.Ng	Disordered solids	73.23.Hk	Coulomb blockade; single-electron tunneling
72.20.Ee	Mobility edges; hopping transport	72.80.Ph	Liquid semiconductors	73.23.Ra	Persistent currents
72.20.Fr	Low-field transport and mobility; piezoresistance	72.80.Rj	Fullerenes and related materials	73.25.+i	<b>Surface conductivity and carrier phenomena</b>
72.20.Ht	High-field and nonlinear effects	72.80.Sk	Insulators	73.30.+y	<b>Surface double layers, Schottky barriers, and work functions</b> ( <i>see also</i> 82.45.Mp <i>Thin layers, films, monolayers, membranes in electrochemistry</i> )
72.20.Jv	Charge carriers: generation, recombination, lifetime, and trapping	72.80.Tm	Composite materials	73.40.-c	<b>Electronic transport in interface structures</b>
72.20.My	Galvanomagnetic and other magnetotransport effects	72.90.+y	<b>Other topics in electronic transport in condensed matter (restricted to new topics in section 72)</b>	73.40.Cg	Contact resistance, contact potential
72.20.Pa	Thermoelectric and thermomagnetic effects	73.	<b>Electronic structure and electrical properties of surfaces, interfaces, thin films, and low-dimensional structures</b> ( <i>for electronic structure and electrical properties of superconducting films and low-dimensional structures, see</i> 74.78.-w; <i>for computational methodology for electronic structure calculations in condensed matter, see</i> 71.15.-m)	73.40.Ei	Rectification
72.25.-b	<b>Spin polarized transport</b> ( <i>for ballistic magnetoresistance, see</i> 75.47.Jn; <i>for spin polarized transport devices, see</i> 85.75.-d)	73.20.-r	<b>Electron states at surfaces and interfaces</b>	73.40.Gk	Tunneling ( <i>for tunneling in quantum Hall effects, see</i> 73.43.Jn)
72.25.Ba	Spin polarized transport in metals	73.20.At	Surface states, band structure, electron density of states	73.40.Jn	Metal-to-metal contacts
72.25.Dc	Spin polarized transport in semiconductors	73.20.Fz	Weak or Anderson localization	73.40.Kp	III-V semiconductor-to-semiconductor contacts, <i>p-n</i> junctions, and heterojunctions
72.25.Fe	Optical creation of spin polarized carriers	73.20.Hb	Impurity and defect levels; energy states of adsorbed species	73.40.Lq	Other semiconductor-to-semiconductor contacts, <i>p-n</i> junctions, and heterojunctions
72.25.Hg	Electrical injection of spin polarized carriers	73.20.Jc	Delocalization processes	73.40.Mr	Semiconductor-electrolyte contacts
72.25.Mk	Spin transport through interfaces	73.20.Mf	Collective excitations (including excitons, polarons, plasmons and other charge-density excitations) ( <i>for collective excitations in quantum Hall effects, see</i> 73.43.Lp)	73.40.Ns	Metal-nonmetal contacts
72.25.Pn	Current-driven spin pumping	73.20.Qt	Electron solids	73.40.Qv	Metal-insulator-semiconductor structures (including semiconductor-to-insulator)
72.25.Rb	Spin relaxation and scattering	73.21.-b	<b>Electron states and collective excitations in multilayers, quantum wells, mesoscopic, and nanoscale systems</b> ( <i>for electron states in nanoscale materials, see</i> 73.22.-f)	73.40.Rw	Metal-insulator-metal structures
72.30.+q	<b>High-frequency effects; plasma effects</b>	73.21.Ac	Multilayers	73.40.Sx	Metal-semiconductor-metal structures
72.40.+w	<b>Photoconduction and photovoltaic effects</b>	73.21.Cd	Superlattices	73.40.Ty	Semiconductor-insulator-semiconductor structures
72.50.+b	<b>Acoustoelectric effects</b>			73.40.Vz	Semiconductor-metal-semiconductor structures
				73.43.-f	<b>Quantum Hall effects</b>
				73.43.Cd	Theory and modeling
				73.43.Fj	Novel experimental methods; measurements
				73.43.Jn	Tunneling
				73.43.Lp	Collective excitations
				73.43.Nq	Quantum phase transitions

- 73.43.Qt Magnetoresistance (*see also* 75.47. —m Magnetotransport phenomena; materials for magnetotransport in magnetic properties and materials)
- · · · Optical properties, *see* 78.66. —w
- 73.50. —h Electronic transport phenomena in thin films** (*for electronic transport in mesoscopic systems, see* 73.23. —b; *see also* 73.40. —c Electronic transport in interface structures; *for electronic transport in nanoscale materials and structures, see* 73.63. —b)
- 73.50.Bk General theory, scattering mechanisms
- 73.50.Dn Low-field transport and mobility; piezoresistance
- 73.50.Fq High-field and nonlinear effects
- 73.50.Gr Charge carriers: generation, recombination, lifetime, trapping, mean free paths
- 73.50.Jt Galvanomagnetic and other magnetotransport effects (including thermomagnetic effects)
- 73.50.Lw Thermoelectric effects
- 73.50.Mx High-frequency effects; plasma effects
- 73.50.Pz Photoconduction and photovoltaic effects
- 73.50.Rb Acoustoelectric and magnetoacoustic effects
- 73.50.Td Noise processes and phenomena
- 73.61. —r Electrical properties of specific thin films** (*for optical properties of thin films, see* 78.20. —e and 78.66. —w; *for magnetic properties of thin films, see* 75.70. —i)
- 73.61.At Metal and metallic alloys
- 73.61.Cw Elemental semiconductors
- 73.61.Ey III–V semiconductors
- 73.61.Ga II–VI semiconductors
- 73.61.Jc Amorphous semiconductors; glasses
- 73.61.Le Other inorganic semiconductors
- 73.61.Ng Insulators
- 73.61.Ph Polymers; organic compounds
- 73.61.Wp Fullerenes and related materials
- 73.63. —b Electronic transport in nanoscale materials and structures** (*see also* 73.23. —b Electronic transport in mesoscopic systems)
- 73.63.Bd Nanocrystalline materials
- 73.63.Fg Nanotubes
- 73.63.Hs Quantum wells
- 73.63.Kv Quantum dots
- 73.63.Nm Quantum wires
- 73.63.Rt Nanoscale contacts
- 73.90. +f Other topics in electronic structure and electrical properties of surfaces, interfaces, thin films, and low-dimensional structures** (Restricted to new topics in section 73)
- 74. Superconductivity** (*for superconducting devices, see* 85.25. —j)
- 74.10. +v Occurrence, potential candidates**
- 74.20. —z Theories and models of superconducting state**
- 74.20.De Phenomenological theories (two-fluid, Ginzburg–Landau, etc.)
- 74.20.Fg BCS theory and its development
- 74.20.Mn Nonconventional mechanisms (spin fluctuations, polarons and bipolarons, resonating valence bond model, anyon mechanism, marginal Fermi liquid, Luttinger liquid, etc.)
- 74.20.Rp Pairing symmetries (other than s-wave)
- 74.25. —q Properties of type I and type II superconductors**
- 74.25.Bt Thermodynamic properties
- 74.25.Dw Superconductivity phase diagrams
- 74.25.Fy Transport properties (electric and thermal conductivity, thermoelectric effects, etc.)
- 74.25.Gz Optical properties
- 74.25.Ha Magnetic properties
- 74.25.Jb Electronic structure
- 74.25.Kc Phonons
- 74.25.Ld Mechanical and acoustical properties, elasticity, and ultrasonic attenuation
- 74.25.Nf Response to electromagnetic fields (nuclear magnetic resonance, surface impedance, etc.)
- 74.25.Op Mixed states, critical fields, and surface sheaths
- 74.25.Qt Vortex lattices, flux pinning, flux creep
- 74.25.Sv Critical currents
- 74.40. +k Fluctuations (noise, chaos, nonequilibrium superconductivity, localization, etc.)**
- 74.45. +c Proximity effects; Andreev effect; SN and SNS junctions**
- 74.50. +r Tunneling phenomena; point contacts, weak links, Josephson effects** (*for SQUIDs, see* 85.25.Dq; *for Josephson devices, see* 85.25.Cp; *for Josephson junction arrays, see* 74.81.Fa)
- 74.62. —c Transition temperature variations**
- 74.62.Bf Effects of material synthesis, crystal structure, and chemical composition
- 74.62.Dh Effects of crystal defects, doping and substitution
- 74.62.Fj Pressure effects
- 74.62.Yb Other effects
- 74.70. —b Superconducting materials** (*for cuprates see* 74.72. —h)
- 74.70.Ad Metals; alloys and binary compounds (including Al<sub>5</sub>, MgB<sub>2</sub>, etc.)
- 74.70.Dd Ternary, quaternary and multinary compounds (including Chevrel phases, borocarbides, etc.)
- 74.70.Kn Organic superconductors
- 74.70.Pq Ruthenates
- 74.70.Tx Heavy-fermion superconductors
- 74.70.Wz Fullerenes and related materials
- 74.72. —h Cuprate superconductors (high-*T<sub>c</sub>* and insulating parent compounds)**
- 74.72.Bk Y-based cuprates
- 74.72.Dn La-based cuprates
- 74.72.Hs Bi-based cuprates
- 74.72.Jt Other cuprates, including Tl and Hg-based cuprates
- 74.78. —w Superconducting films and low-dimensional structures**
- 74.78.Bz High-*T<sub>c</sub>* films
- 74.78.Db Low-*T<sub>c</sub>* films
- 74.78.Fk Multilayers, superlattices, heterostructures
- 74.78.Na Mesoscopic and nanoscale systems
- 74.81. —g Inhomogeneous superconductors and superconducting systems**
- 74.81.Bd Granular, melt-textured, amorphous and composite superconductors
- 74.81.Fa Josephson junction arrays and wire networks
- 74.90. +n Other topics in superconductivity (restricted to new topics in section 74)**
- 75. Magnetic properties and materials** (*for magnetic properties related to treatment conditions, see* 81.40.Rs; *for magnetic properties of superconductors, see* 74.25.Ha; *for magnetic properties of rocks and minerals, see* 91.60.Pn)
- 75.10. —b General theory and models of magnetic ordering** (*see also* 05.50. +q Lattice theory and statistics)
- 75.10.Dg Crystal-field theory and spin Hamiltonians
- 75.10.Hk Classical spin models
- 75.10.Jm Quantized spin models
- 75.10.Lp Band and itinerant models
- 75.10.Nr Spin-glass and other random models



75.10.Pq	Spin chain models	75.47.Gk	Colossal magnetoresistance	75.90.+w	Other topics in magnetic properties and materials (restricted to new topics in section 75)
<b>75.20.–g</b>	<b>Diamagnetism, paramagnetism, and superparamagnetism</b>	75.47.Jn	Ballistic magnetoresistance		
75.20.Ck	Nonmetals	75.47.Lx	Manganites		
75.20.En	Metals and alloys	75.47.Np	Metals and alloys		
75.20.Hr	Local moment in compounds and alloys; Kondo effect, valence fluctuations, heavy fermions ( <i>see also 72.15.Qm Scattering mechanisms and Kondo effect in electronic conduction of metals and alloys</i> )	75.47.Pq	Other materials		
<b>75.25.+z</b>	<b>Spin arrangements in magnetically ordered materials (including neutron and spin-polarized electron studies, synchrotron-source x-ray scattering, etc.) (for devices exploiting spin polarized transport, <i>see 85.75.–d</i>)</b>	<b>75.50.–y</b>	<b>Studies of specific magnetic materials</b>	<b>76. Magnetic resonances and relaxations in condensed matter, Mössbauer effect</b>	
		75.50.Bb	Fe and its alloys	<b>76.20.+q</b>	<b>General theory of resonances and relaxations</b>
		75.50.Cc	Other ferromagnetic metals and alloys	<b>76.30.–v</b>	<b>Electron paramagnetic resonance and relaxation (<i>see also 33.35.+r Electron resonance and relaxation in atomic and molecular physics</i>)</b>
		75.50.Dd	Nonmetallic ferromagnetic materials	76.30.Da	Ions and impurities: general
		75.50.Ee	Antiferromagnetics	76.30.Fc	Iron group (3d) ions and impurities (Ti–Cu)
		75.50.Gg	Ferrimagnetics	76.30.He	Platinum and palladium group (4d and 5d) ions and impurities (Zr–Ag and Hf–Au)
		75.50.Kj	Amorphous and quasicrystalline magnetic materials	76.30.Kg	Rare-earth ions and impurities
		75.50.Lk	Spin glasses and other random magnets	76.30.Lh	Other ions and impurities
<b>75.30.–m</b>	<b>Intrinsic properties of magnetically ordered materials (for critical point effects, <i>see 75.40.–s</i>)</b>	75.50.Mm	Magnetic liquids	76.30.Mi	Color centers and other defects
75.30.Cr	Saturation moments and magnetic susceptibilities	75.50.Pp	Magnetic semiconductors	76.30.Pk	Conduction electrons
75.30.Ds	Spin waves ( <i>for spin-wave resonance, <i>see 76.50.+g</i></i> )	75.50.Ss	Magnetic recording materials ( <i>see also 85.70.–w Magnetic devices</i> )	76.30.Rn	Free radicals
75.30.Et	Exchange and superexchange interactions ( <i>see also 71.70.–d Level splitting and interactions</i> )	75.50.Tt	Fine-particle systems; nanocrystalline materials	<b>76.40.+b</b>	<b>Diamagnetic and cyclotron resonances</b>
75.30.Fv	Spin-density waves	75.50.Vv	High coercivity materials	<b>76.50.+g</b>	<b>Ferromagnetic, antiferromagnetic, and ferrimagnetic resonances; spin-wave resonance (<i>see also 75.30.Ds Spin waves</i>)</b>
75.30.Gw	Magnetic anisotropy	75.50.Ww	Permanent magnets		
75.30.Hx	Magnetic impurity interactions	75.50.Xx	Molecular magnets	<b>76.60.–k</b>	<b>Nuclear magnetic resonance and relaxation (<i>see also 33.25.+k Nuclear resonance and relaxation in atomic and molecular physics and 82.56.–b Nuclear magnetic resonance in physical chemistry and chemical physics</i>)</b>
75.30.Kz	Magnetic phase boundaries (including magnetic transitions, metamagnetism, etc.)	<b>75.60.–d</b>	<b>Domain effects, magnetization curves, and hysteresis</b>	76.60.Cq	Chemical and Knight shifts
75.30.Mb	Valence fluctuation, Kondo lattice, and heavy-fermion phenomena ( <i>see also 71.27.–a Strongly correlated electron systems, heavy fermions</i> )	75.60.Ch	Domain walls and domain structure ( <i>for magnetic bubbles, <i>see 75.70.Kw</i></i> )	76.60.Es	Relaxation effects
75.30.Sg	Magnetocaloric effect, magnetic cooling	75.60.Ej	Magnetization curves, hysteresis, Barkhausen and related effects	76.60.Gv	Quadrupole resonance
75.30.Wx	Spin crossover	75.60.Jk	Magnetization reversal mechanisms	76.60.Jx	Effects of internal magnetic fields
<b>75.40.–s</b>	<b>Critical-point effects, specific heats, short-range order (<i>see also 65.40.–b Heat capacities of solids</i>)</b>	75.60.Lr	Magnetic aftereffects	76.60.Lz	Spin echoes
75.40.Cx	Static properties (order parameter, static susceptibility, heat capacities, critical exponents, etc.)	75.60.Nt	Magnetic annealing and temperature–hysteresis effects	76.60.Pc	NMR imaging ( <i>for medical NMR imaging, <i>see 87.61.–c</i></i> )
75.40.Gb	Dynamic properties (dynamic susceptibility, spin waves, spin diffusion, dynamic scaling, etc.)	<b>75.70.–i</b>	<b>Magnetic properties of thin films, surfaces, and interfaces (for magnetic properties of nanostructures, <i>see 75.75.+a</i>)</b>	<b>76.70.–r</b>	<b>Magnetic double resonances and cross effects (<i>see also 33.40.+f Multiple resonances in atomic and molecular physics</i>)</b>
75.40.Mg	Numerical simulation studies	75.70.Ak	Magnetic properties of monolayers and thin films	76.70.Dx	Electron–nuclear double resonance (ENDOR), electron double resonance (ELDOR)
<b>75.45.+j</b>	<b>Macroscopic quantum phenomena in magnetic systems</b>	75.70.Cn	Magnetic properties of interfaces (multilayers, superlattices, heterostructures)	76.70.Fz	Double nuclear magnetic resonance (DNMR), dynamical nuclear polarization
<b>75.47.–m</b>	<b>Magnetotransport phenomena; materials for magnetotransport (for spintronics, <i>see 85.75.–d; see also 72.15.Gd, 73.50.Jt, 73.43.Qt, and 72.25.–b in transport phenomena</i>)</b>	75.70.Kw	Domain structure (including magnetic bubbles)	76.70.Hb	Optically detected magnetic resonance (ODMR)
75.47.De	Giant magnetoresistance	75.70.Rf	Surface magnetism	<b>76.75.+i</b>	<b>Muon spin rotation and relaxation</b>
		<b>75.75.+a</b>	<b>Magnetic properties of nanostructures</b>	<b>76.80.+y</b>	<b>Mössbauer effect; other <math>\gamma</math>-ray</b>
		<b>75.80.+q</b>	<b>Magnetomechanical and magnetoelectric effects, magnetostriction</b>		
		...	<i>Galvanomagnetic effects, <i>see 72.15.Gd and 72.20.My</i></i>		
		...	<i>Magneto-optical effects, <i>see 78.20.Ls</i></i>		

- spectroscopy** (see also 33.45. +x *Mo<sup>2+</sup>ssbauer spectra—in atomic and molecular physics*)
- · · · *Magnetic resonance spectrometers, 07.57.Pt*
- 76.90.+d Other topics in magnetic resonances and relaxations (restricted to new topics in section 76)**
- 77. Dielectrics, piezoelectrics, and ferroelectrics and their properties** (for conductivity phenomena, see 72.20. –i and 72.80. –r; for dielectric properties related to treatment conditions, see 81.40.Tv)
- 77.22.–d Dielectric properties of solids and liquids**
- 77.22.Ch Permittivity (dielectric function)
- 77.22.Ej Polarization and depolarization
- 77.22.Gm Dielectric loss and relaxation
- 77.22.Jp Dielectric breakdown and space-charge effects
- 77.55.+f Dielectric thin films**
- 77.65.–j Piezoelectricity and electromechanical effects**
- 77.65.Bn Piezoelectric and electrostrictive constants
- 77.65.Dq Acoustoelectric effects and surface acoustic waves (SAW) in piezoelectrics (see also 43.35.Pt *Surface waves in solids and liquids—in acoustics appendix; for surface acoustic wave transducers, see 43.38.Rh—in acoustics appendix*)
- 77.65.Fs Electromechanical resonance; quartz resonators
- 77.65.Ly Strain-induced piezoelectric fields
- 77.70.+a Pyroelectric and electrocaloric effects**
- 77.80.–e Ferroelectricity and antiferroelectricity**
- 77.80.Bh Phase transitions and Curie point
- 77.80.Dj Domain structure; hysteresis
- 77.80.Fm Switching phenomena
- 77.84.–s Dielectric, piezoelectric, ferroelectric, and antiferroelectric materials** (for nonlinear optical materials, see 42.70.Mp; for dielectric materials in electrochemistry, see 82.45.Un)
- 77.84.Bw Elements, oxides, nitrides, borides, carbides, chalcogenides, etc.
- 77.84.Dy Niobates, titanates, tantalates, PZT ceramics, etc.
- 77.84.Fa KDP- and TGS-type crystals
- 77.84.Jd Polymers; organic compounds
- 77.84.Lf Composite materials
- 77.84.Nh Liquids, emulsions, and suspensions; liquid crystals (for structure of liquid crystals, see 61.30. –v)
- 77.90.+k Other topics in dielectrics, piezoelectrics, and ferroelectrics and their properties (restricted to new topics in section 77)**
- 78. Optical properties, condensed-matter spectroscopy and other interactions of radiation and particles with condensed matter**
- 78.20.–e Optical properties of bulk materials and thin films** (for optical properties related to materials treatment, see 81.40.Tv; for optical materials, see 42.70.–a; for optical properties of superconductors, see 74.25.Gs; for optical properties of rocks and minerals, see 91.60.Mk)
- 78.20.Bh Theory, models, and numerical simulation
- 78.20.Ci Optical constants (including refractive index, complex dielectric constant, absorption, reflection and transmission coefficients, emissivity)
- 78.20.Ek Optical activity
- 78.20.Fm Birefringence
- 78.20.Hp Piezo-, elasto-, and acoustooptical effects; photoacoustic effects
- 78.20.Jq Electrooptical effects
- 78.20.Ls Magnetooptical effects
- 78.20.Nv Thermooptical and photothermal effects
- · · · *Nonlinear optical properties, see 42.65. –k*
- 78.30.–j Infrared and Raman spectra** (for vibrational states in crystals and disordered systems, see 63.20. –e and 63.50. +x respectively)
- 78.30.Am Elemental semiconductors and insulators
- 78.30.Cp Liquids
- 78.30.Er Solid metals and alloys
- 78.30.Fs III–V and II–VI semiconductors
- 78.30.Hv Other nonmetallic inorganics
- 78.30.Jw Organic compounds, polymers
- 78.30.Ly Disordered solids
- 78.30.Na Fullerenes and related materials
- 78.35.+c Brillouin and Rayleigh scattering; other light scattering** (for Raman scattering, see 78.30. –j)
- 78.40.–q Absorption and reflection spectra: visible and ultraviolet** (for infrared spectra, see 78.30. –j)
- 78.40.Dw Liquids
- 78.40.Fy Semiconductors
- 78.40.Ha Other nonmetallic inorganics
- 78.40.Kc Metals, semimetals, and alloys
- 78.40.Me Organic compounds and polymers
- 78.40.Pg Disordered solids
- 78.40.Ri Fullerenes and related materials
- 78.45.+h Stimulated emission** (see also 42.55. –f *Lasers*)
- 78.47.+p Time-resolved optical spectroscopies and other ultrafast optical measurements in condensed matter** (see also 42.65.Re—in nonlinear optics; 82.53. –k *Femtochemistry in physical chemistry and chemical physics*)
- · · · *Impurity and defect absorption in solids, see 78.30. –j and 78.40. –q*
- 78.55.–m Photoluminescence, properties and materials**
- 78.55.Ap Elemental semiconductors
- 78.55.Bq Liquids
- 78.55.Cr III–V semiconductors
- 78.55.Et II–VI semiconductors
- 78.55.Fv Solid alkali halides
- 78.55.Hx Other solid inorganic materials
- 78.55.Kz Solid organic materials
- 78.55.Mb Porous materials
- 78.55.Qr Amorphous materials; glasses and other disordered solids
- 78.60.–b Other luminescence and radiative recombination**
- 78.60.Fi Electroluminescence
- 78.60.Hk Cathodoluminescence, ionoluminescence
- 78.60.Kn Thermoluminescence
- 78.60.Mq Sonoluminescence, triboluminescence
- 78.60.Ps Chemiluminescence (see also 42.55.Ks *Chemical lasers*)
- 78.66.–w Optical properties of specific thin films** (for optical properties of low-dimensional, mesoscopic, and nanoscale materials, see 78.67. –n; for optical properties of surfaces, see 78.68. +m)
- 78.66.Bz Metals and metallic alloys
- 78.66.Db Elemental semiconductors and insulators
- 78.66.Fd III–V semiconductors
- 78.66.Hf II–VI semiconductors
- 78.66.Jg Amorphous semiconductors; glasses
- 78.66.Li Other semiconductors
- 78.66.Nk Insulators
- 78.66.Qn Polymers; organic compounds
- 78.66.Sq Composite materials
- 78.66.Tr Fullerenes and related materials
- 78.66.Vs Fine-particle systems
- 78.67.–n Optical properties of low-dimensional, mesoscopic, and nanoscale materials and structures**

78.67.Bf Nanocrystals and nanoparticles  
 78.67.Ch Nanotubes  
 78.67.De Quantum wells  
 78.67.Hc Quantum dots  
 78.67.Lt Quantum wires  
 78.67.Pt Multilayers; superlattices

**78.68.+m Optical properties of surfaces**

**78.70.–g Interactions of particles and radiation with matter**

78.70.Bj Positron annihilation (*for positron states, see 71.60.+z in electronic structure of bulk materials; for positronium chemistry, see 82.30.Gg in physical chemistry and chemical physics*)

78.70.Ck X-ray scattering  
 78.70.Dm X-ray absorption spectra  
 78.70.En X-ray emission spectra and fluorescence  
 78.70.Gq Microwave and radio-frequency interactions  
 78.70.Nx Neutron inelastic scattering

**78.90.+t Other topics in optical properties, condensed matter spectroscopy and other interactions of particles and radiation with condensed matter (restricted to new topics in section 78)**

**79. Electron and ion emission by liquids and solids; impact phenomena**

**79.20.–m Impact phenomena (including electron spectra and sputtering)**

79.20.Ap Theory of impact phenomena; numerical simulation  
 79.20.Ds Laser-beam impact phenomena  
 79.20.Fv Electron impact: Auger emission  
 79.20.Hx Electron impact: secondary emission  
 79.20.Kz Other electron-impact emission phenomena  
 79.20.La Photon- and electron-stimulated desorption  
 79.20.Mb Positron emission  
 79.20.Rf Atomic, molecular, and ion beam impact and interactions with surfaces  
 . . . . *Electron and ion channeling, see 61.85.+p*  
 79.20.Uv Electron energy loss spectroscopy (*see also 82.80.Pv Electron spectroscopy in physical chemistry and chemical physics; 34.80.–i Electron scattering in atomic and molecular physics*)

**79.40.+z Thermionic emission**

**79.60.–i Photoemission and photoelectron spectra**

79.60.Bm Clean metal, semiconductor, and insulator surfaces  
 79.60.Dp Adsorbed layers and thin films  
 79.60.Fr Polymers; organic compounds  
 79.60.Ht Disordered structures  
 79.60.Jv Interfaces; heterostructures; nanostructures

**79.70.+q Field emission, ionization, evaporation, and desorption**

**79.75.+g Exoelectron emission**

**79.90.+b Other topics in electron and ion emission by liquids and solids and impact phenomena (restricted to new topics in section 79)**

## 80. INTERDISCIPLINARY PHYSICS AND RELATED AREAS OF SCIENCE AND TECHNOLOGY

### 81. Materials science

#### 81.05.—t Specific materials: fabrication, treatment, testing and analysis

- · · · Superconducting materials, *see* 74.70.—b and 74.72.—h
- · · · Magnetic materials, *see* 75.50.—y
- · · · Optical materials, *see* 42.70.—a
- · · · Dielectric, piezoelectric, and ferroelectric materials, *see* 77.84.—s
- · · · Colloids, gels, and emulsions, *see* 82.70.Dd, Gg, Kj respectively
- · · · Biological materials, *see* 87.14.—g
- · · · Molecular sieves, zeolites, and other complex materials, *see* 82.75.—z

81.05.Bx Metals, semimetals, and alloys

81.05.Cy Elemental semiconductors (*for semiconductors in electrochemistry, see* 82.45.Vp)

81.05.Dz II–VI semiconductors

81.05.Ea III–V semiconductors

81.05.Gc Amorphous semiconductors

81.05.Hd Other semiconductors

81.05.Je Ceramics and refractories (including borides, carbides, hydrides, nitrides, oxides, and silicides) (*for ceramics in electrochemistry, see* 82.45.Yz)

81.05.Kf Glasses (including metallic glasses)

81.05.Lg Polymers and plastics; rubber; synthetic and natural fibers; organometallic and organic materials (*for polymers and organic materials in electrochemistry, see* 82.45.Wx)

81.05.Mh Cermets, ceramic and refractory composites

81.05.Ni Dispersion-, fiber-, and platelet-reinforced metal-based composites

81.05.Pj Glass-based composites, vitroceraamics

81.05.Qk Reinforced polymers and polymer-based composites

81.05.Rm Porous materials; granular materials (*for granular superconductors, see* 74.81.Bd)

81.05.Tp Fullerenes and related materials

81.05.Uw Carbon, diamond, graphite

81.05.Zx New materials: theory, design, and fabrication

**81.07.—b Nanoscale materials and structures: fabrication and characterization** (*for nanostructured materials in electrochemistry, see* 82.45.Yz; *for nanoparticles in polymers, see* 82.35.Np *in physical chemistry and chemical physics*)

81.07.Bc Nanocrystalline materials

81.07.De Nanotubes

81.07.Lk Nanocontacts

81.07.Nb Molecular nanostructures

81.07.Pr Organic-inorganic hybrid nanostructures

81.07.St Quantum wells

81.07.Ta Quantum dots

81.07.Vb Quantum wires

81.07.Wx Nanopowders

**81.10.—h Methods of crystal growth; physics of crystal growth** (*for crystal structure, see* section 61)

81.10.Aj Theory and models of crystal growth; physics of crystal growth, crystal morphology and orientation

81.10.Bk Growth from vapor

81.10.Dn Growth from solutions

81.10.Fq Growth from melts; zone melting and refining

81.10.Jt Growth from solid phases (including multiphase diffusion and recrystallization)

81.10.Mx Growth in microgravity environments

**81.15.—z Methods of deposition of films and coatings; film growth and epitaxy** (*for structure of thin films, see* 68.55.—a; *see also* 85.40.Sz *Deposition technology in microelectronics*)

81.15.Aa Theory and models of film growth

81.15.Cd Deposition by sputtering

81.15.Ef Vacuum deposition

81.15.Fg Laser deposition

81.15.Gh Chemical vapor deposition (including plasma-enhanced CVD, MOCVD, etc.) (*for chemistry of MOCVD, see* 82.33.Ya *in physical chemistry and chemical physics*)

81.15.Hi Molecular, atomic, ion, and chemical beam epitaxy

81.15.Jj Ion and electron beam-assisted deposition; ion plating (*see also* 52.77.Dq *Plasma-based ion implantation and deposition in physics of plasmas*)

81.15.Kk Vapor phase epitaxy; growth from vapor phase

81.15.Lm Liquid phase epitaxy; deposition from liquid phases (melts, solutions, and surface layers on liquids)

81.15.Np Solid phase epitaxy; growth from solid phases

81.15.Pq Electrodeposition, electroplating

81.15.Rs Spray coating techniques

**81.16.—c Methods of nanofabrication and processing** (*for femtosecond probing of semiconductor nanostructures, see* 82.53.Mj *in physical chemistry and chemical physics*)

81.16.Be Chemical synthesis methods (*for electrochemical synthesis, see* 82.45.Aa)

81.16.Dn Self-assembly

81.16.Fg Supramolecular and biochemical assembly

81.16.Hc Catalytic methods

81.16.Mk Laser-assisted deposition

81.16.Nd Nanolithography

81.16.Pr Nanooxidation (*see also* 82.37.Np *Single molecule reaction kinetics in physical chemistry and chemical physics*)

81.16.Rf Nanoscale pattern formation

81.16.Ta Atom manipulation (*see also* 82.37.Gk *STM and AFM manipulation of a single molecule in physical chemistry and chemical physics*; 39.25.+k *Atom manipulation in atomic and molecular physics*)

**81.20.—n Methods of materials synthesis and materials processing** (*for ion implantation and doping, see* 61.72.Tr, Vv, and Ww)

· · · · Crystal growth, *see* 81.10.—h

· · · · Film deposition, film growth and epitaxy, *see* 81.15.—z

81.20.Ev Powder processing: powder metallurgy, compaction, sintering, mechanical alloying, and granulation

81.20.Fw Sol–gel processing, precipitation

81.20.Hy Forming; molding, extrusion etc.

81.20.Ka Chemical synthesis; combustion synthesis (*for electrochemical synthesis, see* 82.45.Aa)

· · · · Chemical vapor deposition, *see* 81.15.Gh

81.20.Rg Aerosols in materials synthesis and processing

81.20.Vj Joining; welding

81.20.Wk Machining, milling

81.20.Ym Purification

**81.30.—t Phase diagrams and microstructures developed by solidification and solid–solid phase transformations** (*see also* 64.70.Kb *Solid–solid transitions*)

81.30.Bx Phase diagrams of metals and alloys

81.30.Dz Phase diagrams of other materials (*for phase diagrams of superconductors, see* 74.25.Dw)

81.30.Fb Solidification

81.30.Hd Constant-composition solid–solid phase transformations: polymorphic, massive, and order–disorder

81.30.Kf Martensitic transformations



81.30.Mh	Solid-phase precipitation ( <i>see also</i> 64.75.+g <i>Solubility, segregation, and mixing; phase separation</i> )	81.70.Cv	<i>Nondestructive testing: ultrasonic testing, photoacoustic testing</i>	82.20.Wt	Computational modeling; simulation
81.40.—z	<b>Treatment of materials and its effects on microstructure and properties</b>	81.70.Ex	Nondestructive testing: electromagnetic testing, eddy-current testing	82.20.Xr	Quantum effects in rate constants (tunneling, resonances, etc.)
81.40.Cd	Solid solution hardening, precipitation hardening, and dispersion hardening; aging	81.70.Fy	Nondestructive testing: optical methods	82.20.Yn	Solvent effects on reactivity
81.40.Ef	Cold working, work hardening; annealing, post-deformation annealing, quenching, tempering recovery, and crystallization	81.70.Ha	Testing in microgravity environments	82.30.—b	<b>Specific chemical reactions; reaction mechanisms</b>
81.40.Gh	Other heat and thermomechanical treatments	81.70.Jb	Chemical composition analysis, chemical depth and dopant profiling	82.30.Cf	Atom and radical reactions; chain reactions; molecule-molecule reactions
81.40.Jj	Elasticity and anelasticity, stress-strain relations	81.70.Pg	Thermal analysis, differential thermal analysis (DTA), differential thermogravimetric analysis	82.30.Fi	Ion–molecule, ion–ion, and charge-transfer reactions ( <i>see also</i> 34.70.+e <i>Charge transfer in atomic and molecular collisions</i> )
81.40.Lm	Deformation, plasticity, and creep ( <i>see also</i> 83.50.—v <i>Deformation and flow in rheology</i> )	81.70.Tx	Computed tomography	. . . .	<i>Charge transfer in enzymes, see</i> 82.39.Jn
81.40.Np	Fatigue, corrosion fatigue, embrittlement, cracking, fracture and failure	81.90.+c	<b>Other topics in materials science (restricted to new topics in section 81)</b>	82.30.Gg	Positronium chemistry ( <i>see also</i> 36.10.Dr <i>Positronium, muonium, muonic atoms and molecules in atomic and molecular physics; 78.70.Bj Positron annihilation in interactions of particles and radiation with matter</i> )
81.40.Pq	Friction, lubrication, and wear	82.	<b>Physical chemistry and chemical physics</b>	82.30.Hk	Chemical exchanges (substitution, atom transfer, abstraction, disproportionation, and group exchange)
81.40.Rs	Electrical and magnetic properties (related to treatment conditions)	. . . .	<i>Electronic structure theory, see also 33.15.—p in Atomic and molecular physics, section 71 in Condensed matter, and 87.15.Aa in Biological and medical physics</i>	82.30.Lp	Decomposition reactions (pyrolysis, dissociation, and fragmentation)
81.40.Tv	Optical and dielectric properties (related to treatment conditions)	82.20.—w	<b>Chemical kinetics and dynamics</b>	82.30.Nr	Association, addition, insertion, cluster formation
81.40.Vw	Pressure treatment ( <i>see also</i> 62.50.+p <i>High-pressure and shock-wave effects in solids and liquids</i> )	82.20.Bc	State selected dynamics and product distribution ( <i>see also</i> 34.50.Pi <i>State-to-state scattering analyses in scattering of atoms and molecules</i> )	82.30.Qt	Isomerization and rearrangement
81.40.Wx	Radiation treatment (particle and electromagnetic) ( <i>see also</i> 61.80.—x <i>Physical radiation effects, radiation damage</i> )	82.20.Db	Transition state theory and statistical theories of rate constants	82.30.Rs	Hydrogen bonding, hydrophilic effects
. . . .	<i>Etching, corrosion, oxidation, and other surface treatments, see</i> 81.65.—b	82.20.Ej	Quantum theory of reaction cross section	82.30.Vy	Homogeneous catalysis in solution, polymers and zeolites ( <i>for heterogeneous catalysis in zeolites, see</i> 82.75.Qt )
81.65.—b	<b>Surface treatments</b> ( <i>see also</i> 85.40.—e <i>Microelectronics: LSI, VLSI, ULSI; integrated circuit fabrication technology</i> )	82.20.Fd	Collision theories; trajectory models	. . . .	<i>Enzyme kinetics, see</i> 82.39.Fk
81.65.Cf	Surface cleaning, etching, patterning ( <i>see also</i> 52.77.Bn <i>Etching and cleaning in physics of plasmas</i> )	82.20.Gk	Electronically non-adiabatic reactions	. . . .	<i>Protein folding kinetics, see</i> 87.15.Cc <i>in biological and medical physics</i>
81.65.Kn	Corrosion protection ( <i>see also</i> 82.45.Bb <i>Corrosion and passivation in electrochemistry</i> )	82.20.Hf	Product distribution ( <i>for state selected dynamics and product distribution, see</i> 82.20.Bc)	82.33.—z	<b>Reactions in various media</b>
81.65.Lp	Surface hardening: nitridation, carburization, carbonitridation	82.20.Kh	Potential energy surfaces for chemical reactions ( <i>for potential energy surfaces for collisions, see</i> 34.20.Mq <i>in atomic and molecular collisions and interactions</i> )	82.33.De	Reactions in supercritical fluids
81.65.Mq	Oxidation	82.20.Ln	Semiclassical theory of reactions and/or energy transfer	82.33.Fg	Reactions in clusters ( <i>see also</i> 36.40.Jn <i>Reactivity of clusters in atomic and molecular physics</i> )
81.65.Ps	Polishing, grinding, surface finishing	82.20.Ln	Semiclassical theory of reactions and/or energy transfer	82.33.Hk	Reactions on clusters
81.65.Rv	Passivation ( <i>see also</i> 82.45.Bb <i>Corrosion and passivation in electrochemistry</i> )	82.20.Nk	Classical theories of reactions and/or energy transfer	82.33.Jx	Reactions in zeolites
81.65.Tx	Gettering	82.20.Pm	Rate constants, reaction cross sections, and activation energies	82.33.Ln	Reactions in sol gels, aerogels, porous media
81.70.—q	<b>Methods of materials testing and analysis</b> ( <i>for specific chemical analysis methods, see</i> 82.80.—d)	82.20.Rp	State to state energy transfer ( <i>see also</i> 31.70.Hq <i>Time-dependent phenomena, and 34.50.Pi state-to-state scattering analyses—in atomic and molecular physics</i> )	82.33.Nq	Reactions in micells
81.70.Bt	Mechanical testing, impact tests, static and dynamic loads	82.20.Sb	Correlation function theory of rate constants and its applications	82.33.Pt	Solid state chemistry
		82.20.Tr	Kinetic isotope effects including muonium	. . . .	<i>Reactions in complex biological systems, see</i> 82.39.Rt
		82.20.Uv	Stochastic theories of rate constants	82.33.Tb	Atmospheric chemistry ( <i>see also</i> 92.60.Hp and 94.10.Fa <i>in geophysics</i> )

	vapor deposition methods ( <i>for methods of vapor deposition of films and coatings, see 81.15.Gh, Kk in materials science</i> )				electrochemistry ( <i>see also 77.84. –s Dielectric, piezoelectric, ferroelectric, and antiferroelectric materials</i> )
<b>82.35. –x</b>	<b>Polymers; properties; reactions; polymerization</b> ( <i>for polymers in electrochemistry, see 82.45.Wx</i> )	<b>82.40. –g</b>	<b>Chemical kinetics and reactions: special regimes and techniques</b>		
82.35.Cd	Conducting polymers	. . . .	<i>Chemically reactive flows, see 47.70.Fw in fluid dynamics</i>	82.45.Vp	Semiconductor materials in electrochemistry ( <i>see also 81.05.Cy, Dz, Ea, Gc, Hd in specific materials</i> )
82.35.Ej	Nonlinear optics with polymers ( <i>see also 42.65. –k in nonlinear optics</i> )	82.40.Bj	Oscillations, chaos, and bifurcations		
82.35.Gh	Polymers on surfaces; adhesion ( <i>see also 68.35.Np Adhesion in surfaces and interfaces</i> )	82.40.Ck	Pattern formation in reactions with diffusion, flow and heat transfer ( <i>see also 47.54. +r Pattern selection; pattern formation and 47.32.Cc Vortex dynamics in fluid dynamics</i> )	82.45.Wx	Polymers and organic materials in electrochemistry ( <i>see also 82.35. –x Polymers; properties; reactions; polymerization</i> )
82.35.Jk	Copolymers, phase transitions, structure	82.40.Fp	Shock wave initiated reactions, high-pressure chemistry ( <i>see also 47.40.Nm Shock wave interactions and shock effects in fluid dynamics, and 62.50. +p high-pressure and shock wave effects in solids and liquids</i> )	82.45.Xy	Ceramics in electrochemistry ( <i>see also 81.05.Je, Mh in specific materials</i> )
82.35.Lr	Physical properties of polymers			82.45.Yz	Nanostructured materials in electrochemistry ( <i>for nanofabrication, see 81.16. –c in materials science</i> )
82.35.Np	Nanoparticles in polymers ( <i>see also 81.07. –b Nanoscale materials and structures: fabrication and characterization</i> )	82.40.Np	Temporal and spatial patterns in surface reactions		
82.35.Pq	Biopolymers, biopolymerization ( <i>see also 87.15.Rn Reactions and kinetics; polymerization in biological and medical physics</i> )	82.40.Qt	Complex chemical systems ( <i>for complex biological systems, see 82.39.Rt</i> )	<b>82.47. –a</b>	<b>Applied electrochemistry</b>
82.35.Rs	Polyelectrolytes	. . . .	<i>Stochastic theories of chemical kinetics, see 82.20.Uv</i>	82.47.Aa	Lithium-ion batteries
. . . .	<i>Protein properties, folding, see 87.15.Cc and 87.14.Ee in biological and medical physics</i>	<b>82.45. –h</b>	<b>Electrochemistry and electrophoresis</b>	82.47.Cb	Lead-acid, nickel-metal hydride and other batteries ( <i>for lithium-ion batteries, see 82.47.Aa</i> )
. . . .	<i>Enzymes, see 82.39.Fk and 87.14.Ee</i>	82.45.Aa	Electrochemical synthesis ( <i>see also 81.16.Be Chemical synthesis methods in nanofabrication and 81.20.Ka Chemical synthesis; combustion synthesis in materials synthesis</i> )	82.47.Ed	Solid-oxide fuel cells (SOFC)
. . . .	<i>DNA/RNA, see 82.39.Pj and 87.14.Gg</i>	82.45.Bb	Corrosion and passivation ( <i>see also 81.65.Kn Corrosion protection and 81.65.Rv Passivation in surface treatments</i> )	82.47.Gh	Proton exchange membrane (PEM) fuel cells
<b>82.37. –j</b>	<b>Single molecule kinetics</b>	82.45.Cc	Anodic films	82.47.Jk	Photoelectrochemical cells, photoelectrochromic and other hybrid electrochemical energy storage devices ( <i>see also 84.60.Jd Photoelectric conversion, solar cells and arrays</i> )
82.37.Gk	STM and AFM manipulations of a single molecule ( <i>for atom manipulation see 39.25. +k in atomic and molecular physics; see also 81.16.Ta Atom manipulation in methods of nanofabrication and processing</i> )	82.45.Fk	Electrodes	82.47.Lh	Molten-carbonate fuel cells (MCFC)
82.37.Np	Single molecule reaction kinetics, dissociation, etc.	82.45.Gj	Electrolytes ( <i>for polyelectrolytes, see also 82.35.Rs and 82.45.Wx; see also 66.30.Hs Self-diffusion and ionic conduction in nonmetals</i> )	82.47.Nj	Polymer-electrolyte fuel cells (PEFC)
82.37.Rs	Single molecule manipulation of proteins and other biological molecules	82.45.Hk	Electrolysis	82.47.Pm	Phosphoric-acid fuel cells (PAFC); other fuel cells
82.37.Vb	Single molecule photochemistry	82.45.Jn	Surface structure, reactivity and catalysis ( <i>see also 82.65. +r Surface and interface chemistry; heterogeneous catalysis at surfaces</i> )	82.47.Rs	Electrochemical sensors
<b>82.39. –k</b>	<b>Chemical kinetics in biological systems</b> ( <i>see also 87.15.Rn Reactions and kinetics; polymerization in biological and medical physics, and 82.45.Tv Bioelectrochemistry</i> )	82.45.Mp	Thin layers, films, monolayers, membranes ( <i>for anodic films, see 82.45.Cc; for surface double layers, see 73.30. +y in electronic structure of surfaces</i> )	82.47.Tp	Electrochemical displays
82.39.Fk	Enzyme kinetics	82.45.Qr	Electrodeposition and electrodisolution ( <i>see also 81.15.Pq Electrodeposition, electroplating in materials science</i> )	82.47.Uv	Electrochemical capacitors; supercapacitors
82.39.Jn	Charge (electron, proton) transfer in biological systems	82.45.Rr	Electroanalytical chemistry ( <i>see also 82.80.Fk Electrochemical methods in chemical analysis and related physical methods of analysis</i> )	82.47.Wx	Electrochemical engineering
. . . .	<i>Protein folding, see 87.15.Cc in biological and medical physics</i>	82.45.Tv	Bioelectrochemistry ( <i>see also 82.39. –k Chemical kinetics in biological systems</i> )	<b>82.50. –m</b>	<b>Photochemistry</b> ( <i>for single molecule photochemistry, see 82.37.Vb</i> )
82.39.Pj	Nucleic acids, DNA and RNA bases			. . . .	<i>Optical spectroscopy, see 32.30. –r and 33.20. –t in atomic and molecular physics; 78.30. –j, 78.35. +c, 78.40. –q, and 78.47. +p in condensed matter physics</i>
82.39.Rt	Reactions in complex biological systems	82.45.Un	Dielectric materials in	82.50.Bc	Processes caused by infrared radiation
82.39.Wj	Ion exchange, dialysis, osmosis, electro-osmosis, membrane processes			82.50.Hp	Processes caused by visible and UV light
				82.50.Kx	Processes caused by X-rays or $\gamma$ -rays
				82.50.Nd	Control of photochemical reactions
				82.50.Pt	Multiphoton processes
				. . . .	<i>Potential energy surfaces for photochemistry and spectroscopy, see 31.50.Df</i>

· · · ·	Surface crossings, non-adiabatic couplings, <i>see</i> 31.50.Gh	82.60.Nh	Thermodynamics of nucleation ( <i>see also</i> 64.60.Qb Nucleation—in equations of state, phase equilibria and phase transitions)	82.80.Dx	Analytical methods involving electronic spectroscopy
<b>82.53.—k</b>	<b>Femtochemistry</b> ( <i>see also</i> 78.47.+p Time-resolved optical spectroscopies and other ultrafast optical measurements in condensed matter; 42.65.Re Ultrafast processes; optical generation and pulse compression in nonlinear optics)	82.60.Qr	Thermodynamics of nanoparticles	82.80.Ej	X-ray, Mössbauer, and other $\gamma$ -ray spectroscopic analysis methods
82.53.Eb	Pump probe studies of photodissociation	· · · ·	Irreversible thermodynamics, nonequilibrium thermodynamics, <i>see</i> 05.70.Ln	82.80.Fk	Electrochemical methods ( <i>see also</i> 82.45.Rr Electroanalytical chemistry; for electrochemical sensors, <i>see</i> 82.47.Rs)
82.53.Hn	Pump probe experiments with bound states	<b>82.65.+r</b>	<b>Surface and interface chemistry; heterogeneous catalysis at surfaces</b> ( <i>for temporal and spatial patterns in surface reactions, see</i> 82.40.Np; <i>see also</i> 82.45.Jn Surface structure, reactivity and catalysis in electrochemistry)	82.80.Gk	Analytical methods involving vibrational spectroscopy
82.53.Kp	Coherent spectroscopy of atoms and molecules	· · · ·	Chemisorption/physisorption: adsorbates on surfaces, <i>see</i> 68.43.—h	82.80.Ha	Analytical methods involving rotational spectroscopy
82.53.Mj	Femtosecond probing of semiconductor nanostructures ( <i>see also</i> 81.16.—c Methods of nanofabrication and processing)	<b>82.70.—y</b>	<b>Disperse systems; complex fluids</b> ( <i>see also</i> 82.33.—z reactions in various media; <i>for quantum optical phenomena in dispersive media, see</i> 42.50.Nn)	82.80.Jp	Activation analysis and other radiochemical methods
82.53.Ps	Femtosecond probing of biological molecules	82.70.Dd	Colloids	82.80.Kq	Energy-conversion spectro-analytical methods (e.g., photoacoustic, photothermal, and optogalvanic spectroscopic methods)
82.53.St	Femtochemistry of adsorbed molecules ( <i>for adsorbate structure, see</i> 68.43.Bc, Fg in chemisorption/physisorption: adsorbates on surfaces)	82.70.Gg	Gels and sols	82.80.Ms	Mass spectrometry (including SIMS, multiphoton ionization and resonance ionization mass spectrometry, MALDI)
82.53.Uv	Femtosecond probes of molecules in liquids	82.70.Kj	Emulsions and suspensions	82.80.Nj	Fourier transform mass spectrometry
82.53.Xa	Femtosecond probes of molecules in solids and of molecular solids	82.70.Rr	Aerosols and foams	82.80.Pv	Electron spectroscopy (x-ray photoelectron (XPS), Auger electron spectroscopy (AES), etc.)
<b>82.56.—b</b>	<b>Nuclear magnetic resonance</b> ( <i>see also</i> 33.25.+k Nuclear resonance and relaxation in atomic and molecular physics; 76.60.—k Nuclear magnetic resonance and relaxation; 76.70.—r Magnetic double resonances and cross effects in condensed matter)	82.70.Uv	Surfactants, micellar solutions, vesicles, lamellae, amphiphilic systems, (hydrophilic and hydrophobic interactions) ( <i>see also</i> 82.30.Rs Hydrogen bonding, hydrophilic effects in specific chemical reactions)	82.80.Qx	Ion cyclotron resonance mass spectrometry
82.56.Dj	High resolution NMR	· · · ·	Nanoscale materials and structures, <i>see</i> 81.07.—b	82.80.Rt	Time of flight mass spectrometry
82.56.Fk	Multidimensional NMR	· · · ·	Preparation and assembly of nanostructures, <i>see</i> 81.16.—c	82.80.Yc	Rutherford backscattering (RBS), and other methods of chemical analysis
82.56.Hg	Multinuclear NMR	· · · ·	Phase transitions of nanostructures, <i>see</i> 64.70.Nd	<b>82.90.+j</b>	<b>Other topics in physical chemistry and chemical physics (restricted to new topics in section 82)</b>
82.56.Jn	Pulse sequences in NMR	· · · ·	Spectroscopy of nanostructures, <i>see</i> 78.67.—n	<b>83. Rheology</b> ( <i>see also</i> section 47 Fluid dynamics)	
82.56.Lz	Diffusion	<b>82.75.—z</b>	<b>Molecular sieves, zeolites, clathrates, and other complex solids</b>	<b>83.10.—y</b>	<b>Fundamentals and theoretical</b>
82.56.Na	Relaxation	82.75.Fq	Synthesis, structure determination, structure modeling	83.10.Bb	Kinematics of deformation and flow
82.56.Pp	NMR of biomolecules	82.75.Jn	Measurements and modeling of molecule migration in zeolites	· · · ·	Fluid dynamics (non-Newtonian fluids), <i>see</i> 47.50.+d
82.56.Ub	Structure determination with NMR	82.75.Mj	Measurements and simulation of properties (optical, structural) of molecules in zeolites	83.10.Ff	Continuum mechanics ( <i>see also</i> section 46 Continuum mechanics of solids)
· · · ·	ENDOR( <i>see</i> 76.70.Dx in condensed matter, and 33.40.+f in atomic and molecular physics)	82.75.Qt	Mechanism and kinetics of catalysis in zeolites (measurements or simulations)	83.10.Gr	Constitutive relations
· · · ·	NMR imaging, <i>see</i> 76.60.Pc in condensed matter	82.75.Vx	Clusters in zeolites	83.10.Kn	Reptation and tube theories
<b>82.60.—s</b>	<b>Chemical thermodynamics</b> ( <i>see also</i> 05.70.—a Thermodynamics)	<b>82.80.—d</b>	<b>Chemical analysis and related physical methods of analysis</b> ( <i>for related instrumentation, see</i> section 07; <i>for chemical analysis techniques in biophysics, see</i> 87.64.—t)	83.10.Mj	Molecular dynamics, Brownian dynamics
82.60.Cx	Enthalpies of combustion, reaction, and formation	82.80.Bg	Chromatography	83.10.Pp	Particle dynamics
82.60.Fa	Heat capacities and heats of phase transitions			83.10.Rs	Computer simulation of molecular and particle dynamics
82.60.Hc	Chemical equilibria and equilibrium constants			83.10.Tv	Structural and phase changes
82.60.Lf	Thermodynamics of solutions			<b>83.50.—v</b>	<b>Deformation and flow</b>
				83.50.Ax	Steady shear flows, viscometric flow
				83.50.Ha	Flow in channels
				83.50.Jf	Extensional flow and combined shear and extension



83.50.Lh	Slip boundary effects (interfacial and free surface flows) ( <i>see also</i> 47.45.Gx <i>Slip flows in fluid dynamics</i> )	83.80.Ya	Processed food	84.32.Tt	Capacitors ( <i>for electrochemical capacitors and supercapacitors, see</i> 82.47.Uv)
83.50.Rp	Wall slip and apparent slip	<b>83.85.—c</b>	<b>Techniques and apparatus</b>	84.32.Vv	Fuses
83.50.Uv	Material processing (extension, molding, etc.)	83.85.Cg	Rheological measurements—rheometry	<b>84.35.+i</b>	<b>Neural networks</b> ( <i>for optical neural networks, see</i> 42.79.Ta, <i>see also</i> 07.05.Mh <i>Neural networks, fuzzy logic, artificial intelligence in computers in experimental physics; see also</i> 87.18.Sn <i>in multicellular phenomena</i> )
83.50.Xa	Mixing and blending	83.85.Ei	Optical methods; rheo-optics	<b>84.37.+q</b>	<b>Electric variable measurements (including voltage, current, resistance, capacitance, inductance, impedance, and admittance, etc.)</b>
<b>83.60.—a</b>	<b>Material behavior</b>	83.85.Fg	NMR/magnetic resonance imaging ( <i>see also</i> 76.60.Pc <i>NMR imaging in condensed matter</i> )	<b>84.40.—x</b>	<b>Radiowave and microwave (including millimeter wave) technology</b>
83.60.Bc	Linear viscoelasticity	83.85.Hf	X-ray and neutron scattering	. . . .	Microwave, submillimeter wave, and radiowave receivers and detectors, <i>see</i> 07.57.Kp
83.60.Df	Nonlinear viscoelasticity	83.85.Jn	Viscosity measurements	. . . .	Microwave and radiowave spectrometers, <i>see</i> 07.57.Pt
83.60.Fg	Shear rate dependent viscosity	83.85.Lq	Normal stress difference measurements	. . . .	Electromagnetic wave propagation, <i>see</i> 41.20.Jb
83.60.Hc	Normal stress differences and their effects (e.g. rod climbing)	83.85.Ns	Data analysis (interconversion of data computation of relaxation and retardation spectra; time-temperature superposition, etc.)	84.40.Az	Waveguides, transmission lines, striplines
83.60.Jk	Extrudate swell	83.85.Pt	Computational fluid dynamics ( <i>see also</i> 02.70.—c— <i>in mathematical methods in physics; 47.11.+j Computational methods in fluid dynamics</i> )	84.40.Ba	Antennas: theory, components and accessories ( <i>for plasma interactions with antennas, see</i> 52.40.Fd <i>in plasma physics</i> )
83.60.La	Viscoplasticity; yield stress	83.85.Rx	Extensional flow measurement	84.40.Dc	Microwave circuits
83.60.Np	Effects of electric and magnetic fields	83.85.St	Stress relaxation	84.40.Fe	Microwave tubes (e.g., klystrons, magnetrons, traveling-wave, backward-wave tubes, etc.)
83.60.Pq	Time-dependent structure (thixotropy, rheopexy)	83.85.Tz	Creep and/or creep recoil	84.40.Ik	Masers; gyrotrons (cyclotron-resonance masers)
83.60.Rs	Shear rate-dependent structure (shear thinning and shear thickening)	83.85.Vb	Small amplitude oscillatory shear (dynamic mechanical analysis)	84.40.Lj	Microwave integrated electronics
83.60.St	Non-isothermal rheology	<b>83.90.+s</b>	<b>Other topics in rheology (restricted to new topics in section 83)</b>	84.40.Ua	Telecommunications: signal transmission and processing; communication satellites ( <i>for optical communications, see</i> 42.79.Sz <i>in optics</i> )
83.60.Uv	Wave propagation, fracture, and crack healing	<b>84. Electronics; radiowave and microwave technology; direct energy conversion and storage</b>		84.40.Xb	Telemetry: remote control, remote sensing; radar
83.60.Wc	Flow instabilities	<b>84.30.—r</b>	<b>Electronic circuits</b> ( <i>for integrated circuits, see</i> 85.40.—e, <i>for microwave circuits, see</i> 84.40.Dc)	<b>84.47.+w</b>	<b>Vacuum tubes</b> ( <i>see also</i> 85.45.—w <i>Vacuum microelectronics</i> )
83.60.Yz	Drag reduction	84.30.Bv	Circuit theory (including computer-aided circuit design and analysis)	. . . .	Phototubes, <i>see</i> 85.60.Ha
<b>83.80.—k</b>	<b>Material type</b> ( <i>see also</i> 82.70.—y <i>Disperse systems; complex fluids and 82.35.—x Polymers: properties; reactions; polymerization in physical chemistry and chemical physics</i> )	84.30.Jc	Power electronics; power supply circuits ( <i>see also</i> 84.70.+p <i>High-current and high-voltage technology; for superconducting high-power technology, see</i> 84.71.—b)	. . . .	Microwave tubes, <i>see</i> 84.40.Fe
83.80.Ab	Solids: e.g., composites, glasses, semicrystalline polymers	84.30.Le	Amplifiers	<b>84.50.+d</b>	<b>Electric motors</b>
83.80.Fg	Granular solids	84.30.Ng	Oscillators, pulse generators, and function generators	<b>84.60.—h</b>	<b>Direct energy conversion and storage</b> ( <i>see also</i> 89.30.—g <i>Energy resources; for electrochemical conversion, see</i> 82.47.—a)
83.80.Gv	Electro- and magnetorheological fluids	84.30.Qi	Modulators and demodulators; discriminators, comparators, mixers, limiters, and compressors	84.60.Bk	Performance characteristics of energy conversion systems; figure of merit
83.80.Hj	Suspensions, dispersions, pastes, slurries, colloids	84.30.Sk	Pulse and digital circuits	84.60.Jt	Photoelectric conversion: solar cells and arrays ( <i>for solar collectors and concentrators, see</i> 42.79.Ek <i>in optics</i> )
83.80.Iz	Emulsions and foams	84.30.Vn	Filters	84.60.Lw	Magnetohydrodynamic conversion
83.80.Jx	Reacting systems: thermosetting polymers, chemorheology, rheokinetics	<b>84.32.—y</b>	<b>Passive circuit components</b> ( <i>see also</i> 07.50.+q <i>Electrical and electronic components, instruments, and techniques</i> )		
83.80.Kn	Physical gels and microgels	84.32.Dd	Connectors, relays, and switches		
83.80.Lz	Physiological materials (e.g. blood, collagen, etc.)	84.32.Ff	Conductors, resistors (including thermistors, varistors, and photoresistors)		
83.80.Mc	Other natural materials (e.g. wood and other vegetable materials)	84.32.Hh	Inductors and coils; wiring		
83.80.Nb	Geological materials: Earth, magma, ice, rocks, etc.				
83.80.Qr	Surfactant and micellar systems, associated polymers				
83.80.Rs	Polymer solutions				
83.80.Sg	Polymer melts				
83.80.Tc	Polymer blends				
83.80.Uv	Block copolymers				
83.80.Va	Elastomeric polymers				
83.80.Wx	Filled elastomers				
83.80.Xz	Liquid crystals: nematic, cholesteric, smectic, discotic, etc.				



	(for MHD generators, see 52.75.Fk—in plasma physics)	85.30.De	Semiconductor-device characterization, design, and modeling	85.45.Fd	Field emission displays (FEDs) . . . . Capacitors, see 84.32.Tt
84.60.Ny	Thermionic conversion (for thermionic generators, see 52.75.Fk—in plasma physics)	85.30.Fg	Bulk semiconductor and conductivity oscillation devices (including Hall effect devices, space-charge-limited devices, and Gunn effect devices)	<b>85.50.—n</b>	<b>Dielectric, ferroelectric, and piezoelectric devices</b>
84.60.Rb	Thermoelectric, electrogasdynamic and other direct energy conversion	85.30.Hi	Surface barrier, boundary, and point contact devices	85.50.Gk	Non-volatile ferroelectric memories
84.60.Ve	Energy storage systems, including capacitor banks	85.30.Kk	Junction diodes	<b>85.60.—q</b>	<b>Optoelectronic devices</b> (see also 42.79.—e Optical elements, devices and systems)
<b>84.70.+p</b>	<b>High-current and high-voltage technology: power systems; power transmission lines and cables</b> (for superconducting cables, see 84.71.Fk)	85.30.Mn	Junction breakdown and tunneling devices (including resonance tunneling devices)	85.60.Bt	Optoelectronic device characterization, design, and modeling
<b>84.71.—b</b>	<b>Superconducting high-power technology</b> (see also 84.30.Jc Power electronics; power supply circuits)	85.30.Pq	Bipolar transistors	85.60.Dw	Photodiodes; phototransistors; photoresistors
84.71.Ba	Superconducting magnets; magnetic levitation devices	85.30.Rs	Thyristors	85.60.Gz	Photodetectors (including infrared and CCD detectors) (for superconducting infrared detectors, see 85.25.Pb; for superconducting optical, x-ray and $\gamma$ -ray detectors, see 85.25.Oj; see also 07.57.Kp in instruments)
84.71.Fk	Superconducting cables	85.30.Tv	Field effect devices	85.60.Ha	Photomultipliers; phototubes and photocathodes
84.71.Mn	Superconducting wires, fibers, and tapes	<b>85.35.—p</b>	<b>Nanoelectronic devices</b>	85.60.Jb	Light-emitting devices
<b>84.90.+a</b>	<b>Other topics in electronics, radiowave and microwave technology, and direct energy conversion and storage</b> (restricted to new topics in section 84)	85.35.Be	Quantum well devices (quantum dots, quantum wires, etc.)	85.60.Pg	Display systems (for field emission display, see 85.45.Fd, for optical display devices, see 42.79.Kr; for electrochemical displays, see 82.47.Tp see also 07.07.Hj Display and recording equipment, oscilloscopes, TV cameras, etc.)
<b>85. Electronic and magnetic devices; microelectronics</b>		85.35.Ds	Quantum interference devices	<b>85.65.+h</b>	<b>Molecular electronic devices</b>
. . . .	Vacuum tubes, see 84.47.+w	85.35.Gv	Single electron devices	<b>85.70.—w</b>	<b>Magnetic devices</b>
. . . .	Microwave tubes, see 84.40.Fe	85.35.Kt	Nanotube devices	. . . .	Molecular magnets, see 75.50.Xx
. . . .	Phototubes, see 85.60.Ha	<b>85.40.—e</b>	<b>Microelectronics: LSI, VLSI, ULSI; integrated circuit fabrication technology</b> (see also 85.45.—w Vacuum microelectronics)	. . . .	Magnets, see 07.55.Db
. . . .	Conductors, resistors, and inductors, see 84.32.Ff, Hh	. . . .	Microwave integrated electronics, see 84.40.Lj	. . . .	Superconducting magnets and magnetic levitation devices, see 84.71.Ba
<b>85.25.—j</b>	<b>Superconducting devices</b>	. . . .	Integrated optics, see 42.82.—m	. . . .	Beam bending magnets, see 41.85.Lc
85.25.Am	Superconducting device characterization, design, and modeling	. . . .	Superconducting logic elements and memory devices; microelectronic circuits, see 85.25.Hv	85.70.Ay	Magnetic device characterization, design, and modeling
85.25.Cp	Josephson devices	85.40.Bh	Computer-aided design of microcircuits; layout and modeling	85.70.Ec	Magnetostrictive, magnetoacoustic, and magnetostatic devices (for magnetostrictive transducers, see 43.38.Ct—in acoustics appendix)
85.25.Dq	Superconducting quantum interference devices (SQUIDS)	85.40.Hp	Lithography, masks and pattern transfer	. . . .	Magnetic recording materials, see 75.50.Ss
85.25.Hv	Superconducting logic elements and memory devices; microelectronic circuits	. . . .	Micro- and nano-electromechanical systems (MEMS/NEMS) and devices, see 85.85.+j	85.70.Ge	Ferrite and garnet devices
85.25.Oj	Superconducting optical, x-ray, and $\gamma$ -ray detectors (SIS, NIS, transition edge)	85.40.Ls	Metallization, contacts, interconnects; device isolation	85.70.Kh	Magnetic thin film devices: magnetic heads (magnetoresistive, inductive, etc.); domain-motion devices, etc.
85.25.Pb	Superconducting infrared, submillimeter and millimeter wave detectors	85.40.Qx	Microcircuit quality, noise, performance, and failure analysis	85.70.Li	Other magnetic recording and storage devices (including tapes, disks, and drums)
. . . .	High power superconducting devices, see 84.71.—b	85.40.Ry	Impurity doping, diffusion and ion implantation technology	85.70.Rp	Magnetic levitation, propulsion and control devices (for superconducting-magnetic levitation devices, see 84.71.Ba)
85.25.Qc	Superconducting surface acoustic wave devices and other superconducting devices	85.40.Sz	Deposition technology (for plasma applications in deposition technology, see 52.77.Dq)	85.70.Sq	Magneto-optical devices
<b>85.30.—z</b>	<b>Semiconductor devices</b> (for photodiodes, phototransistors, and photoresistors, see 85.60.Dw; for laser diodes, see 42.55.Px)	. . . .	Bipolar integrated circuits, see 85.30.Pq		
		. . . .	Field effect integrated circuits, see 85.30.Tv		
		85.40.Xx	Hybrid microelectronics; thick films		
		<b>85.45.—w</b>	<b>Vacuum microelectronics</b>		
		. . . .	Microwave vacuum microelectronic devices, see 84.40.—x		
		85.45.Bz	Vacuum microelectronic device characterization, design, and modeling		
		85.45.Db	Field emitters and arrays, cold electron emitters		

- 85.75.-d Magnetoelectronics; spintronics: devices exploiting spin polarized transport or integrated magnetic fields**
- 85.75.Bb Magnetic memory using giant magnetoresistance
- 85.75.Dd Magnetic memory using magnetic tunnel junctions
- 85.75.Ff Reprogrammable magnetic logic
- 85.75.Hh Spin polarized field effect transistors
- 85.75.Mm Spin polarized resonant tunnel junctions
- 85.75.Nn Hybrid Hall devices
- 85.75.Ss Magnetic field sensors using spin polarized transport
- 85.80.-b Thermoelectromagnetic and other devices (for acoustoelectric devices, see 43.38.-p—in acoustics appendix; for electrochemical devices, see 82.47.-a)**
- 85.80.Fi Thermoelectric devices
- 85.80.Jm Magnetoelectric devices
- 85.80.Lp Magnetothermal devices
- 85.85.+j Micro- and nano-electromechanical systems (MEMS/NEMS) and devices**
- 85.90.+h Other topics in electronic and magnetic devices and microelectronics (restricted to new topics in section 85)**

## 87. Biological and medical physics

- 87.10.+e General theory and mathematical aspects**
- 87.14.-g Biomolecules: types**
- 87.14.Cc Lipids
- 87.14.Ee Proteins
- 87.14.Gg DNA, RNA
- 87.15.-v Biomolecules: structure and physical properties**
- 87.15.Aa Theory and modeling; computer simulation
- 87.15.By Structure and bonding
- 87.15.Cc Folding and sequence analysis
- 87.15.He Dynamics and conformational changes
- 87.15.Kg Molecular interactions; membrane-protein interactions
- 87.15.La Mechanical properties
- 87.15.Mi Spectra, photodissociation, and photoionization; luminescence
- 87.15.Nn Properties of solutions; aggregation and crystallization of macromolecules
- 87.15.Rn Reactions and kinetics; polymerization (see also 82.39.-k *Chemical kinetics in biological systems* and 82.35.Pq *Biopolymers, biopolymerization in physical chemistry and chemical physics*)

- 87.15.Tt Electrophoresis (see also 82.45.-h *Electrochemistry and electrophoresis*)
- 87.15.Vv Diffusion
- 87.15.Ya Fluctuations
- 87.16.-b Subcellular structure and processes**
- 87.16.Ac Theory and modeling; computer simulation
- 87.16.Dg Membranes, bilayers, and vesicles
- 87.16.Gj Cell walls
- 87.16.Ka Filaments, microtubules, their networks, and supramolecular assemblies
- 87.16.Nn Motor proteins (myosin, kinesin dynein)
- 87.16.Qp Pseudopods, lamellipods, cilia, and flagella
- 87.16.Sr Chromosomes, histones
- 87.16.Tb Organelles
- 87.16.Uv Active transport processes; ion channels
- 87.16.Xa Signal transduction
- 87.16.Yc Regulatory chemical networks
- 87.17.-d Cellular structure and processes**
- 87.17.Aa Theory and modeling; computer simulation
- 87.17.Ee Growth and division
- 87.17.Jj Cell locomotion; chemotaxis and related directed motion
- 87.17.Nn Electrophysiology of nerve cells
- 87.18.-h Multicellular phenomena**
- 87.18.Bb Computer simulation
- 87.18.Ed Aggregation and other collective behavior of motile cells
- 87.18.Hf Spatiotemporal pattern formation in cellular populations
- 87.18.La Morphogenesis
- 87.18.Pj Chemical waves
- 87.18.Sn Neural networks
- 87.19.-j Properties of higher organisms**
- ... *Physiological optics, see 42.66.-p*
- ... *Physiological acoustics, see 43.64.+r*
- ... *Psychological acoustics, see 43.66.+y*
- ... *Speech production, see 43.70.+i*
- ... *Speech perception, see 43.71.+m*
- ... *Speech processing and communication systems, see 43.72.+g*
- 87.19.Bb Sensory perceptions
- 87.19.Dd Information processing in vision and hearing
- 87.19.Ff Muscles
- 87.19.Hh Cardiac dynamics
- 87.19.Jj Circadian rhythms
- 87.19.La Neuroscience
- 87.19.Nn Electrophysiology
- 87.19.Pp Biothermics

- 87.19.Rr Mechanical properties of tissues and organs
- 87.19.St Movement and locomotion
- 87.19.Tt Rheology of body fluids
- 87.19.Uv Haemodynamics, pneumodynamics
- 87.19.Xx Diseases
- 87.23.-n Ecology and evolution**
- 87.23.Cc Population dynamics and ecological pattern formation
- 87.23.Ge Dynamics of social systems
- 87.23.Kg Dynamics of evolution
- 87.50.-a Effects of radiation and external fields on biomolecules, cells and higher organisms**
- 87.50.Gi Ionizing radiations (ultraviolet, x-rays,  $\gamma$ -rays, ions, electrons, positrons, neutrons, and mesons, etc.)
- 87.50.Hj Optical radiation (near ultraviolet, visible, and infrared)
- 87.50.Jk Radio frequency and microwave radiation (power lines)
- 87.50.Kk Sound and ultrasound
- 87.50.Mn Magnetic fields
- 87.50.Rr Electric fields
- 87.52.-g Radiation monitoring, control, and safety**
- 87.52.Df Low LET: therapeutic and diagnostic x-rays and electrons
- 87.52.Ga Low LET: associated neutron shielding and measurement
- 87.52.Ln High LET
- 87.52.Px Risk/benefit analysis
- 87.52.Tr Regulatory issues
- 87.53.-j Ionizing-radiation therapy physics**
- 87.53.Bn Photon dosimetry: theory and algorithms
- 87.53.Dq Photon dosimetry: measurements
- 87.53.Fs Electron and positron dosimetry: theory and algorithms
- 87.53.Hv Electron and positron dosimetry: measurements
- 87.53.Jw Brachytherapy
- 87.53.Kn Conformal radiation treatment
- 87.53.Ly Stereotactic radiosurgery
- 87.53.Mr Beam intensity modification: wedges, compensators
- 87.53.Na Radioimmunotherapy
- 87.53.Oq Portal imaging in therapy
- 87.53.Pb Proton, neutron, and heavier particle dosimetry: theory and algorithms
- 87.53.Qc Proton, neutron, and heavier particle dosimetry: measurements
- 87.53.Rd Microdosimetry
- 87.53.St Record and verify systems and applications
- 87.53.Tf Treatment planning, optimization, tissue response factors, and dose-volume analysis



<b>89.75.—k</b>	<b>Complex systems</b>				
89.75.Da	Systems obeying scaling laws		89.75.Hc	Networks and genealogical trees	
89.75.Fb	Structures and organization in complex systems		89.75.Kd	Patterns	
					<b>89.90.+n</b> Other topics in areas of applied and interdisciplinary physics(restricted to new topics in section 89)



## 90. GEOPHYSICS, ASTRONOMY, AND ASTROPHYSICS

### 91. Solid Earth physics

#### 91.10.—v Geodesy and gravity

- 91.10.By Mathematical geodesy; general theory
- 91.10.Da Cartography
- 91.10.Fc Space geodetic surveys
- 91.10.Jf Topography; geometric observations
- 91.10.Kg Crustal movements
- 91.10.Lh Photogrammetry
- 91.10.Nj Rotational variations; polar wobble
- 91.10.Pp Gravimetric measurements and instruments
- 91.10.Qm Harmonics of the gravity potential field
- · · · *Relations of gravity observations to tectonics and isostasy, see 91.45.Sx*
- 91.10.Rn Rheology of lithosphere and mantle
- 91.10.Sp Satellite orbits
- 91.10.Tq Earth tides
- 91.10.Vr Ocean/Earth/atmosphere interaction
- 91.10.Ws Reference systems

#### 91.25.—r Geomagnetism and paleomagnetism; geoelectricity

- 91.25.Cw Origins and models of the magnetic field; dynamo theories
- 91.25.Dx Archeomagnetism
- 91.25.Ey Interactions between exterior sources and interior properties
- 91.25.Ga Spatial variations: all harmonics and anomalies
- 91.25.Jc Spatial variations attributed to sea floor spreading
- 91.25.Le Time variations: diurnal to secular
- 91.25.Mf Reversals
- 91.25.Ng Paleomagnetism
- 91.25.Ph Magnetostratigraphy
- 91.25.Qi Geoelectricity; electromagnetic induction and conductivity (magnetotelluric effects)

#### 91.30.—f Seismology

- 91.30.Bi Seismic sources (mechanisms, magnitude, moment frequency spectrum)
- 91.30.Dk Seismicity: space and time distribution
- 91.30.Fn Surface and body waves
- 91.30.Ks Free oscillations (periods less than 12 hours)
- 91.30.Mv Strong motions and shock waves
- 91.30.Nw Tsunamis (*for dynamics of oceans, see 92.10.Dh and 92.10.Fj*)
- 91.30.Px Phenomena related to earthquake prediction
- 91.30.Rz Explosion seismology
- 91.30.Tb Volcano seismology
- 91.30.Vc Continental crust seismology
- 91.30.Ye Oceanic crust seismology

#### 91.35.—x Earth's interior structure and properties

- 91.35.Cb Models of interior structure
- 91.35.Dc Heat flow; geothermy
- 91.35.Ed Structure of the Earth's interior below the upper mantle
- 91.35.Gf Structure of the crust and upper mantle
- 91.35.Lj Composition of Earth's interior
- 91.35.Nm Geochronology
- 91.35.Pn Tomography of the Earth's interior (*see also 91.30. —f Seismology*)

#### 91.40.—k Volcanology

- 91.40.Bp Ash deposits
- 91.40.Dr Atmospheric effects (*see also 92.60.Mt Particles and aerosols—in Meteorology*)
- 91.40.Ft Eruptions
- 91.40.Hw Lava

#### 91.45.—c Physics of plate tectonics

- 91.45.Cg Continental margins
- 91.45.Dh Plate tectonics
- 91.45.Ei Neotectonics
- 91.45.Fj Convection currents
- 91.45.Pt Slow vertical crustal movements (including isostasy and postglacial phenomena)
- 91.45.Qv Tomography of plate tectonics
- 91.45.Sx Relations of gravity observations to tectonics and isostasy
- 91.45.Ty Folds and Folding
- 91.45.Vz Fractures and faults
- 91.45.Yb Pluton emplacement

#### 91.50.—r Marine geology and geophysics

- 91.50.Cw Beach, coastal, and shelf processes
- 91.50.Ey Ocean bottom processes (*for ocean basin thermometry, see 43.30.Qd—in acoustics appendix*)
- 91.50.Ga Bathymetry and noncoastal underwater morphology
- 91.50.Jc Turbidity currents, sedimentation (*for acoustics of sediments, see 43.30.Ma in acoustics appendix*)

#### 91.60.—x Physical properties of rocks and minerals (*for rheological properties of geological materials, see 83.80.Nb*)

- 91.60.Ba Elasticity, fracture, and flow
- 91.60.Dc Creep and deformation
- 91.60.Ed Crystal structure and defects
- 91.60.Fe Equations of state
- 91.60.Gf High-pressure behavior
- 91.60.Hg Phase changes
- 91.60.Ki Thermal properties
- 91.60.Lj Acoustic properties
- 91.60.Mk Optical properties

- 91.60.Pn Magnetic and electric properties; environmental magnetism

#### 91.65.—n Geophysical aspects of geology, mineralogy, and petrology (*for geophysical prospecting, see 43.40.Ph—in acoustics appendix*)

- 91.65.Br Geochemical cycles
- 91.65.Dt Isotopic composition/chemistry
- 91.65.Fw Low-temperature geochemistry
- 91.65.Hy Organic geochemistry
- 91.65.Nd Trace elements
- 91.65.Rg Mineral occurrences and deposits
- 91.65.Ti Sedimentary petrology
- 91.65.Vj Major element composition

#### 91.70.—c Information related to geologic time

- 91.70.Bf Cenozoic
- 91.70.Dh Mesozoic
- 91.70.Fj Paleozoic
- 91.70.Hm Precambrian

#### 91.90.+p Other topics in solid Earth physics (restricted to new topics in section 91)

## 92. Hydrospheric and atmospheric geophysics

#### 92.10.—c Physics of the oceans

- 92.10.Bf Physical properties of seawater
- 92.10.Cg Capillary waves
- 92.10.Dh Dynamics of the deep ocean
- 92.10.Ei Coriolis effects
- 92.10.Fj Dynamics of the upper ocean
- 92.10.Gk El Nino
- 92.10.Hm Surface waves, tides, and sea level
- 92.10.Jn Seiches
- 92.10.Kp Sea-air energy exchange processes
- 92.10.Lq Turbulence and diffusion
- 92.10.Mr Thermohaline structure and circulation
- 92.10.Ns Fine structure and microstructure
- 92.10.Pt Optical properties of sea water
- 92.10.Rw Sea ice
- 92.10.Sx Coastal and estuarine oceanography
- 92.10.Ty Fronts and jets
- 92.10.Vz Underwater sound (*see also 43.30.+m in acoustics*)
- 92.10.Wa Sediment transport
- 92.10.Yb Hydrography (*for ocean parameter estimation by acoustical methods, see 43.30.Pc—in acoustics appendix*)
- · · · *Marine geology and geophysics, see 91.50. —r*

#### 92.20.—h Interdisciplinary aspects of oceanography

92.20.Bk	Aerosols	92.70.Er	Biogeochemical processes	94.10.Lf	Convection, diffusion, mixing, turbulence, and fallout
92.20.Cm	Chemistry of the ocean	92.70.Gt	Climate dynamics	94.10.Nh	Cosmic dust
92.20.Gr	Ocean energy extraction	92.70.Jw	Oceans	94.10.Rk	Aurora and airglow
92.20.Hs	Anoxic environments	92.70.Ly	Water cycles	<b>94.20.—y</b>	<b>Physics of the ionosphere</b> ( <i>for ionospheres of the planets, see 96.35.Kx; for radiowave propagation, see 41.20.Jb in electromagnetism; see also section 52 Physics of plasmas and electric discharges</i> )
92.20.Jt	Biological aspects of oceanography	<b>92.90.+x</b>	<b>Other topics in hydrospheric and atmospheric geophysics (restricted to new topics in section 92)</b>	94.20.Bb	Wave propagation
92.20.Kv	Photochemistry	<b>93. Geophysical observations, instrumentation, and techniques</b>		94.20.Dd	Ionospheric structure ( <i>D, E, F, and topside regions</i> ) including steady-state ion densities and temperatures
92.20.Lw	Photosynthesis	<b>93.30.—w</b>	<b>Information related to geographical regions</b>	94.20.Ee	<i>D</i> region
92.20.Mx	Physicochemical properties	93.30.Bz	Africa	94.20.Gg	<i>E</i> region
92.20.Ny	Marine pollution	93.30.Ca	Antarctica	94.20.Ji	<i>F</i> region
92.20.Pz	Bacteria	93.30.Db	Asia	94.20.Kj	Polar cap ionosphere
92.20.Rb	Plankton	93.30.Fd	Australia	94.20.Lk	Topside region
92.20.Td	Radioactivity	93.30.Ge	Europe	94.20.Mm	Plasmasphere
<b>92.40.—t</b>	<b>Hydrology and glaciology</b>	93.30.Hf	North America	94.20.Pp	Plasmapause
92.40.Cy	Modeling; general theory	93.30.Jg	South America	94.20.Qq	Particle precipitation
92.40.Ea	Precipitation	93.30.Kh	Large islands (e.g., Greenland)	94.20.Rr	Interactions between waves and particles
92.40.Fb	Rivers, runoff, and streamflow	93.30.Li	Arctic Ocean	94.20.Ss	Electric fields
92.40.Gc	Erosion and sedimentation	93.30.Mj	Atlantic Ocean	94.20.Tt	Ionospheric soundings
92.40.Je	Evaporation	93.30.Nk	Indian Ocean	94.20.Vv	Ionospheric disturbances and modifications
92.40.Kf	Groundwater	93.30.Pm	Pacific Ocean	94.20.Ww	Plasma motion, convection, or circulation
92.40.Lg	Soil moisture	93.30.Qn	Southern Ocean	94.20.Yx	Interaction between ionosphere and magnetosphere
92.40.Ni	Limnology	93.30.Rp	Regional seas	<b>94.30.—d</b>	<b>Physics of the magnetosphere</b> ( <i>for magnetospheres of the planets, see 96.35.Kx; for radiowave propagation, see 41.20.Jb in electromagnetism; see also section 52 Physics of plasmas and electric discharges</i> )
92.40.Qk	Water quality and water resources	93.30.Sq	Polar regions	94.30.Bg	Magnetic coordinate systems
92.40.Rm	Snow	93.30.Tr	Temperate regions	94.30.Ch	Magnetospheric configuration
92.40.Sn	Ice	93.30.Vs	Tropical regions	94.30.Di	Magnetopause
92.40.Vq	Glaciers	<b>93.55.+z</b>	<b>International organizations, national and international programs</b>	94.30.Ej	Magnetic tail
<b>92.60.—e</b>	<b>Meteorology</b> ( <i>see also 43.28. +h Aeroacoustics and atmospheric sound; 42.68. —w Atmospheric optics; 94.10.Dy Atmospheric structure, pressure, density, and temperature</i> )	<b>93.65.+e</b>	<b>Data acquisition and storage</b>	94.30.Fk	Plasma motion, convection, or circulation
92.60.Bh	General circulation	<b>93.85.+q</b>	<b>Instrumentation and techniques for geophysical research</b>	94.30.Gm	Plasma instabilities
92.60.Dj	Gravity waves, tides, and compressional waves	<b>94. Aeronomy and magnetospheric physics</b>		94.30.Hn	Trapped particles
92.60.Ek	Convection, turbulence, and diffusion	<b>94.10.—s</b>	<b>Physics of the neutral atmosphere</b> ( <i>for atmospheres of the planets, see 96.35.Hv</i> )	94.30.Jp	Ring currents
92.60.Fm	Boundary layer structure and processes	94.10.Bw	General properties of the high atmosphere	94.30.Kq	Electric fields
92.60.Gn	Winds and their effects	94.10.Dy	Atmospheric structure, pressure, density, and temperature (stratosphere, mesosphere, thermosphere, exosphere) ( <i>see also 92.60. —e Meteorology and 92.70. —j Global change</i> )	94.30.Lr	Magnetic storms, substorms
92.60.Hp	Chemical composition and chemical interactions	94.10.Fa	Atmospheric composition (atomic or molecular), chemical reactions and processes ( <i>see also 82.33.Tb Atmospheric chemistry in physical chemistry and chemical physics</i> )	94.30.Ms	Magnetic pulsations
92.60.Jq	Water in the atmosphere (humidity, clouds, evaporation, precipitation)	94.10.Gb	Absorption and scattering of radiation	94.30.Tz	Waves: propagation and excitation
92.60.Ls	Ionic interactions and processes	94.10.Jd	Tides, waves, and winds	94.30.Va	Magnetosheath; interaction with interplanetary space (including solar wind) ( <i>for cosmic-ray interactions, see 13.85.Tp in elementary particle physics; see also 96.40. —z Cosmic rays—in Astronomy</i> )
92.60.Mt	Particles and aerosols ( <i>see also 94.20. —y Physics of the ionosphere</i> )			<b>94.80.+g</b>	<b>Instrumentation for aeronomy</b>
92.60.Nv	Cloud physics; stratus and cumulus clouds				
92.60.Pw	Atmospheric electricity				
92.60.Qx	Storms				
92.60.Ry	Climatology				
92.60.Sz	Air quality and air pollution				
92.60.Ta	Interaction of atmosphere with electromagnetic waves; propagation				
92.60.Vb	Solar radiation				
92.60.Wc	Weather analysis and prediction				
<b>92.70.—j</b>	<b>Global change</b> ( <i>see also 92.60. —e Meteorology</i> )				
92.70.Cp	Atmosphere				

	and magnetospheric studies ( <i>see also</i> 95.55.−n <i>Astronomical and space-research instrumentation in astronomy</i> ; 07.87.+v <i>spaceborne and space research instruments, apparatus, and components in instruments</i> )	95.30.Sf	Relativity and gravitation ( <i>see also</i> section 04 <i>General relativity and gravitation</i> ; 98.80.Jk <i>Mathematical and relativistic aspects of cosmology</i> )		cosmic ray detectors ( <i>see also</i> 29.40.−n <i>Radiation detectors-in nuclear physics</i> )
94.90.+m	Other topics in aeronomy and magnetospheric physics (restricted to new topics in section 94)	95.30.Tg	Thermodynamic processes, conduction, convection, equations of state ( <i>see also</i> 05.70.−a <i>Thermodynamics</i> )	95.55.Ym	Gravitational radiation detectors; mass spectrometers; and other instrumentation and techniques ( <i>see also</i> 04.80.−y <i>Experimental studies of gravity in general relativity and gravitation</i> )
95.	<b>Fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations</b>	95.30.Wi	Dust processes (condensation, evaporation, sputtering, mantle growth, etc.)	95.75.−z	<b>Observation and data reduction techniques; computer modeling and simulation</b>
95.10.−a	<b>Fundamental astronomy</b>	95.35.+d	<b>Dark matter (stellar, interstellar, galactic, and cosmological)</b> ( <i>see also</i> 95.30.Cq <i>Elementary particle processes</i> ; for brown dwarfs, <i>see</i> 97.20.Vs; for galactic halos, <i>see</i> 98.35.Gi or 98.62.Gq; for models of the early Universe, <i>see</i> 97.10.Fy)	95.75.De	Photography and photometry (including microlensing techniques)
95.10.Ce	Celestial mechanics (including <i>n</i> -body problems) ( <i>see also</i> 45.50.Pk in classical mechanics of discrete systems)	95.40.+s	<b>Artificial Earth satellites</b> (for lunar and planetary probes, <i>see</i> 95.55.Pe; <i>see also</i> 07.87.+v in instruments, apparatus, and components common to several branches of physics and astronomy)	95.75.Fg	Spectroscopy and spectrophotometry
· · · ·	<i>Dynamics and kinematics of stellar systems, see</i> 98.10.+z	95.45.+i	<b>Observatories and site testing</b>	95.75.Hi	Polarimetry
95.10.Eg	Orbit determination and improvement	95.55.−n	<b>Astronomical and space-research instrumentation</b> ( <i>see also</i> 94.80.+g <i>Instrumentation for aeronomy and magnetospheric studies</i> ; 07.87.+v <i>Spaceborne and space research instruments, apparatus, and components</i> )	95.75.Kk	Interferometry
95.10.Fh	Chaotic dynamics ( <i>see also</i> 05.45.−a <i>Nonlinear dynamics and nonlinear dynamical systems</i> )	95.55.Aq	Charge-coupled devices, image detectors, and IR detector arrays ( <i>see also</i> 85.60.Gz <i>Photodetectors</i> )	95.75.Mn	Image processing (including source extraction)
95.10.Gi	Eclipses, transits, and occultations	95.55.Br	Astrometric and interferometric instruments	95.75.Pq	Mathematical procedures and computer techniques
95.10.Jk	Astrometry and reference systems	95.55.Cs	Ground-based ultraviolet, optical and infrared telescopes	95.75.Qr	Adaptive and segmented optics ( <i>see also</i> 42.68.Wt <i>Remote sensing; LIDAR and adaptive systems in atmospheric optics</i> )
95.10.Km	Ephemerides, almanacs, and calendars	95.55.Ev	Solar instruments	95.75.Rs	Remote observing techniques
95.30.−k	<b>Fundamental aspects of astrophysics</b>	95.55.Fw	Space-based ultraviolet, optical, and infrared telescopes	95.75.Tv	Digitization techniques ( <i>see also</i> 07.05.Pj <i>Image processing in instruments</i> )
95.30.Cq	Elementary particle processes ( <i>see also</i> section 26 <i>Nuclear astrophysics</i> )	95.55.Jz	Radio telescopes and instrumentation; heterodyne receivers	95.75.Wx	Time series analysis, time variability
95.30.Dr	Atomic processes and interactions ( <i>see also</i> section 32 <i>Atomic properties and interactions with photons</i> ; section 34 <i>Atomic and molecular collision processes and interactions</i> )	95.55.Ka	X- and γ-ray telescopes and instrumentation	95.80.+p	<b>Astronomical catalogs, atlases, sky surveys, databases, retrieval systems, archives, etc.</b>
95.30.Ft	Molecular and chemical processes and interactions ( <i>see also</i> section 33 <i>Molecular properties and interactions with photons</i> ; section 34 <i>Atomic and molecular collision processes and interactions</i> )	95.55.Pe	Lunar, planetary, and deep-space probes	95.85.−e	<b>Astronomical observations (additional primary heading(s) must be chosen with these entries to represent the astronomical objects and/or properties studied)</b>
95.30.Gv	Radiation mechanisms; polarization	95.55.Qf	Photometric, polarimetric, and spectroscopic instrumentation ( <i>see also</i> 07.60.−j <i>Optical instruments, equipment, and techniques</i> )	95.85.Bh	Radio, microwave (>1 mm)
95.30.Jx	Radiative transfer; scattering	95.55.Rg	Photoconductors and bolometers ( <i>see also</i> 07.57.Kp <i>Bolometers, infrared submillimeter wave, microwave, and radiowave receivers and detectors in instruments</i> )	95.85.Fm	Submillimeter (300 m–1 mm)
95.30.Ky	Atomic and molecular data, spectra, and spectral parameters (opacities, rotation constants, line identification, oscillator strengths, <i>gf</i> values, transition probabilities, etc.) ( <i>see also</i> 32.10.−f, 32.30.−r, 32.70.−n, 33.15.−e, 33.20.−t, and 33.70.−w in atomic and molecular physics)	95.55.Sh	Auxiliary and recording instruments; clocks and frequency standards	95.85.Gn	Far infrared (10–300 m)
95.30.Lz	Hydrodynamics	95.55.Vj	Neutrino, muon, pion, and other elementary particle detectors;	95.85.Hp	Infrared (3–10 m)
95.30.Qd	Magnetohydrodynamics and plasmas ( <i>see also</i> 52.30.Cv and 52.72.+v in physics of plasmas)			95.85.Jq	Near infrared (0.75–3 m)
				95.85.Kr	Visible (390–750 nm)
				95.85.Ls	Near ultraviolet (300–390 nm)
				95.85.Mt	Ultraviolet (10–300 nm)
				95.85.Nv	X-ray
				95.85.Pw	γ-ray
				95.85.Ry	Neutrino, muon, pion, and other elementary particles; cosmic rays
				95.85.Sz	Gravitational radiation, magnetic fields, and other observations
				95.90.+v	<b>Historical astronomy and archaeoastronomy; and other topics in fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations</b>
				96.	<b>Solar System</b> ( <i>for the Earth, see sections 91–94</i> )

<b>96.10.+i</b>	<b>General, solar nebula, and cosmogony</b>	96.50.Bh	Solar and interplanetary electric and magnetic fields (including solar wind fields)	97.10.Bt	Star formation
<b>96.20.—n</b>	<b>Moon</b>	96.50.Ci	Solar wind plasma	97.10.Cv	Stellar structure, interiors, evolution, nucleosynthesis, ages
96.20.Br	Origin, formation, and age	96.50.Dj	Interplanetary gas and dust (including gegenschein and zodiacal light)	97.10.Ex	Stellar atmospheres (photospheres, chromospheres, coronae, magnetospheres); radiative transfer; opacity and line formation
96.20.Dt	Features, landmarks, mineralogy, petrology, and atmosphere	96.50.Ek	Solar wind interactions with planets, satellites, and comets (for interactions with Earth, see 94.30.Va)	97.10.Fy	Circumstellar shells, clouds, and expanding envelopes; circumstellar masers ( <i>for interstellar masers, see 98.38.Er or 98.58.Ec</i> )
96.20.Jz	Gravitational field, selenodesy, magnetic fields	96.50.Fm	Shock waves	97.10.Gz	Accretion and accretion disks
96.20.Ka	Cratering	96.50.Gn	Comets	97.10.Jb	Stellar activity
<b>96.30.—t</b>	<b>Planets, their satellites and rings; asteroids</b> ( <i>for comets, see 96.50.Gn</i> )	96.50.Hp	Oort cloud	97.10.Kc	Stellar rotation
96.30.Dz	Mercury	96.50.Jq	Kuiper belt	97.10.Ld	Magnetic and electric fields; polarization of starlight
96.30.Ea	Venus	96.50.Kr	Meteors, meteoroids, and meteor streams	97.10.Me	Mass loss and stellar winds
96.30.Gc	Mars	96.50.Mt	Meteorites, micrometeorites, and tektites	97.10.Nf	Masses
96.30.Kf	Jupiter	96.50.Pw	Particle acceleration	97.10.Pg	Radii
96.30.Mh	Saturn	96.50.Qx	Stream-stream interactions	97.10.Qh	Surface features (including starspots)
96.30.Pj	Uranus	96.50.Ry	Waves and discontinuities	97.10.Ri	Luminosities; magnitudes; effective temperatures, colors, and spectral classification
96.30.Rm	Neptune	<b>96.60.—j</b>	<b>Solar physics</b>	97.10.Sj	Pulsations, oscillations, and stellar seismology
96.30.Sn	Pluto	96.60.Bn	Diameter, figure, rotation, mass	97.10.Tk	Abundances, chemical composition
96.30.Wr	Planetary rings	96.60.Fs	Chemical composition	97.10.Vm	Distances, parallaxes
96.30.Ys	Asteroids (minor planets)	96.60.Hv	Electric and magnetic fields	97.10.Wn	Proper motions and radial velocities (line-of-sight velocities); space motions ( <i>see also 95.10.Jk Astrometry and reference systems</i> )
<b>96.35.—j</b>	<b>Planetary, asteroid, cometary, and satellite characteristics and properties</b> ( <i>see also 97.82.—j for extrasolar planetary systems</i> )	96.60.Jw	Solar interior ( <i>for solar neutrinos, see 26.65.+t in nuclear astrophysics</i> )	97.10.Xq	Luminosity and mass functions
96.35.Cp	Origin, formation, evolution, and ages	96.60.Ly	Oscillations and waves; helioseismology	97.10.Yp	Star counts, distribution, and statistics
96.35.Er	Chemical composition	96.60.Mz	Photosphere, granulation	97.10.Zr	Hertzsprung-Russell, color-magnitude, and color-color diagrams
96.35.Fs	Mass, size; gravitational fields; rotation; orbits	96.60.Na	Chromosphere and chromosphere–corona transition; spicules	<b>97.20.—w</b>	<b>Normal stars (by class): general or individual</b>
96.35.Gt	Surface features, cratering, and topography	96.60.Pb	Corona; coronal loops, streamers, and holes	97.20.Ec	Main-sequence: early-type stars (O and B)
96.35.Hv	Neutral atmospheres	96.60.Qc	Sunspots, faculae, plages	97.20.Ge	Main-sequence: intermediate-type stars (A and F)
96.35.Kx	Ionospheres; magnetospheres	96.60.Rd	Flares, bursts, and related phenomena	97.20.Jg	Main-sequence: late-type stars (G, K, and M)
96.35.Mz	Interiors	96.60.Se	Prominences	97.20.Li	Giant and subgiant stars
96.35.Na	Volcanism and tectonics	96.60.Tf	Solar electromagnetic radiation ( <i>see also 92.60.Vb Solar radiation in meteorology</i> )	97.20.Pm	Supergiant stars
96.35.Pb	Electric and magnetic fields	96.60.Vg	Particle radiation, solar wind, and solar neutrinos ( <i>see also 96.50.Ci Solar wind plasma and 96.50.Ek Solar wind interactions with planets, satellites, and comets; see also 26.65.+t Solar neutrinos in nuclear astrophysics</i> )	97.20.Rp	Faint blue stars (including blue stragglers), white dwarfs, degenerate stars, nuclei of planetary nebulae ( <i>for planetary nebulae, see 98.38.Ly or 98.58.Li</i> )
96.35.Se	Interplanetary comparisons	96.60.Wh	Coronal mass ejection	97.20.Tr	Population II stars (horizontal branch, metal poor, etc.)
<b>96.40.—z</b>	<b>Cosmic rays</b> ( <i>for cosmic rays outside the Solar System, see 98.70.Sa; for cosmic-ray interactions, see 13.85.Tp in hadron-induced high- and super high-energy interactions</i> )	<b>96.90.+c</b>	<b>Other topics on the solar system (restricted to new topics in section 96)</b>	97.20.Vs	Low luminosity stars, subdwarfs, and brown dwarfs
96.40.Cd	Interplanetary propagation and effects	<b>97. Stars</b>		97.20.Wt	Population III stars
96.40.De	Composition, energy spectra, and interactions	<b>97.10.—q</b>	<b>Stellar characteristics and properties</b> ( <i>see also 04.40.Dg Relativistic stars in general relativity and gravitation and section 26 Nuclear astrophysics</i> )	<b>97.21.+a</b>	<b>Pre-main sequence objects, young stellar objects (YSO's) and protostars (T Tauri stars, Orion population, Herbig–Haro objects, Bok globules, bipolar outflows,</b>
96.40.Fg	Energetic solar particles and photons				
96.40.Kk	Solar modulation and geophysical effects				
96.40.Pq	Extensive air showers				
96.40.Tv	Neutrinos and muons				
96.40.Vw	Cosmic-ray effects in meteorites and terrestrial matter				
<b>96.50.—e</b>	<b>Interplanetary space</b> ( <i>for asteroids, see 96.30.Ys</i> )				



	cometary nebulae, etc.) ( <i>see also</i> 98.38.Fs and 98.58.Fd <i>Jets, outflows and bipolar flows in the Milky Way and external galaxies respectively</i> )				
<b>97.30.—b</b>	<b>Variable and peculiar stars (including novae)</b>	<b>97.82.—j</b>	<b>Extrasolar planetary systems</b>	<b>98.38.Er</b>	Interstellar masers ( <i>for circumstellar masers, see 97.10.Fy</i> )
97.30.Dg	Low-amplitude blue variables (alpha Cygni, beta Cephei, delta Scuti, delta Delphini, delta Canis Majoris, SX Phoenicis, etc.)	97.82.Cp	Photometric and spectroscopic detection; coronagraphic detection; interferometric detection	98.38.Fs	Jets, outflows, and bipolar flows ( <i>for pre-main sequence objects, see 97.21.+a</i> )
97.30.Eh	Emission-line stars (Of, Be, Luminous Blue Variables, Wolf-Rayet, etc.)	97.82.Fs	Substellar companions; planets	98.38.Gt	H I regions and 21-cm lines; diffuse, translucent, and high-velocity clouds
97.30.Fi	Chemically peculiar stars (Ap, Am, etc.)	97.82.Jw	Infrared excess; debris disks; protoplanetary disks; exo-zodiacal dust	98.38.Hv	H II regions; emission and reflection nebulae
97.30.Gj	Cepheids (delta Cephei, W Virginis)	<b>97.90.+j</b>	<b>Other topics on stars (restricted to new topics in section 97)</b>	98.38.Jw	Infrared emission
97.30.Hk	Carbon stars, S stars, and related types (C, S, R, and N)			98.38.Kx	Intercloud medium (ICM); hot and highly ionized gas; bubbles
97.30.Jm	Long-period variables (Miras) and semiregulars	<b>98. Stellar systems; interstellar medium; galactic and extragalactic objects and systems; the Universe</b>		98.38.Ly	Planetary nebulae ( <i>for nuclei of planetary nebulae, see also 97.20.Rp</i> )
97.30.Kn	RR Lyrae stars; RV Tauri and PV Telescopii variables	<b>98.10.+z</b>	<b>Stellar dynamics and kinematics</b>	98.38.Mz	Supernova remnants
97.30.Nr	Flare stars (UV Ceti, RS Canum Venaticorum, FU Orionis, R Coronae Borealis variables, etc.)	<b>98.20.—d</b>	<b>Stellar clusters and associations</b>	<b>98.52.—b</b>	<b>Normal galaxies; extragalactic objects and systems (by type)</b>
97.30.Qt	Novae, dwarf novae, recurrent novae, and other cataclysmic (eruptive) variables ( <i>see also 97.80.Gm, Jp Cataclysmic binaries and X-ray binaries</i> )	98.20.Af	Associations of stars (OB, T, R) in the Milky Way	98.52.Cf	Classification and classification systems
97.30.Sw	Unusual and peculiar variables	98.20.Bg	Associations of stars (OB, T, R) in external galaxies	98.52.Eh	Elliptical galaxies
<b>97.60.—s</b>	<b>Late stages of stellar evolution (including black holes)</b> ( <i>see also 04.40.Dg Relativistic stars in general relativity and gravitation</i> )	98.20.Di	Open clusters in the Milky Way	98.52.Lp	Lenticular (S0) galaxies
97.60.Bw	Supernovae ( <i>see also 26.30.+k Nucleosynthesis in novae, supernovae and other explosive stars and 26.50.+x Nuclear physics aspects of supernovae evolution</i> )	98.20.Fk	Open clusters in external galaxies	98.52.Nr	Spiral galaxies
97.60.Gb	Pulsars	98.20.Gm	Globular clusters in the Milky Way	98.52.Sw	Irregular and morphologically peculiar galaxies
97.60.Jd	Neutron stars ( <i>see also 26.60.+c Nuclear matter aspects of neutron stars in nuclear physics</i> )	98.20.Jp	Globular clusters in external galaxies	98.52.Wz	Dwarf galaxies (elliptical, irregular, and spheroidal)
97.60.Lf	Black holes ( <i>see also 04.70.—s Physics of black holes in general relativity and gravitation; for galactic black holes, see 98.35.Jk and 98.62.Js</i> )	<b>98.35.—a</b>	<b>Characteristics and properties of the Milky Way galaxy</b>	<b>98.54.—h</b>	<b>Quasars; active or peculiar galaxies, objects, and systems</b>
<b>97.80.—d</b>	<b>Binary and multiple stars</b>	98.35.Ac	Origin, formation, evolution, age, and star formation	98.54.Aj	Quasars ( <i>for quasar absorption and emission-line systems; Lyman forest, see 98.62.Ra</i> )
97.80.Af	Astrometric and interferometric binaries	98.35.Bd	Chemical composition and chemical evolution	98.54.Cm	Active and peculiar galaxies and related systems (including BL Lacertae objects, blazars, Seyfert galaxies, Markarian galaxies, and active galactic nuclei)
97.80.Di	Visual binaries	98.35.Ce	Mass and mass distribution	98.54.Ep	Starburst galaxies and infrared excess galaxies
97.80.Fk	Spectroscopic binaries; close binaries	98.35.Df	Kinematics, dynamics, and rotation	98.54.Gr	Radio galaxies
97.80.Gm	Cataclysmic binaries (novae, dwarf novae, recurrent novae, and nova-like objects); symbiotic stars ( <i>see also 97.30.Qt Novae</i> )	98.35.Eg	Electric and magnetic fields	98.54.Kt	Protogalaxies; primordial galaxies
97.80.Hn	Eclipsing binaries	98.35.Gi	Galactic halo	<b>98.56.—p</b>	<b>Local group; Magellanic Clouds</b>
97.80.Jp	X-ray binaries ( <i>see also 98.70.Qy X-ray sources and 97.60.Gb Pulsars</i> )	98.35.Hj	Spiral arms and galactic disk	98.56.Ew	Elliptical galaxies
97.80.Kq	Multiple stars	98.35.Jk	Galactic center, bar, circumnuclear matter, and bulge (including black hole and distance measurements) ( <i>see also 04.70.—s Physics of black holes in general relativity and gravitation</i> )	98.56.Ne	Spiral galaxies (M31 and M33)
		98.35.Ln	Stellar content and populations; morphology and overall structure	98.56.Si	Magellanic Clouds and other irregular galaxies
		98.35.Mp	Infall and accretion	98.56.Tj	Magellanic stream
		98.35.Nq	Galactic winds and fountains	98.56.Wm	Dwarf galaxies (elliptical, irregular, and spheroidal)
		98.35.Pr	Solar neighborhood	<b>98.58.—w</b>	<b>Interstellar medium (ISM) and nebulae in external galaxies</b>
		<b>98.38.—j</b>	<b>Interstellar medium (ISM) and nebulae in Milky Way</b>	98.58.Ay	Physical properties (abundances, electron density, magnetic fields, scintillation, scattering, kinematics, dynamics, turbulence, etc.)
		98.38.Am	Physical properties (abundances, electron density, magnetic fields, scintillation, scattering, kinematics, dynamics, turbulence, etc.)	98.58.Bz	Atomic, molecular, chemical, and grain processes
		98.38.Bn	Atomic, molecular, and chemical, and grain processes	98.58.Ca	Interstellar dust grains; diffuse emission; infrared cirrus
		98.38.Cp	Interstellar dust grains; diffuse emission; infrared cirrus	98.58.Db	Molecular clouds, H <sub>2</sub> clouds, dense clouds, and dark clouds
		98.38.Dq	Molecular clouds, H <sub>2</sub> clouds, dense clouds, and dark clouds		

98.58.Ec	Interstellar masers ( <i>for circumstellar masers, see 97.10.Fy</i> )		galaxies ( <i>see also 98.80.Es</i> <i>Observational cosmology</i> )	98.70.Vc	Background radiations
98.58.Fd	Jets, outflows and bipolar flows ( <i>for pre-main sequence objects, see 97.21.+a</i> )	98.62.Qz	Magnitudes and colors; luminosities	<b>98.80.—k</b>	<b>Cosmology</b> ( <i>see also section 04</i> <i>General relativity and gravitation;</i> <i>for origin and evolution of galaxies,</i> <i>see 98.62.Ai; for elementary</i> <i>particle and nuclear processes, see</i> <i>95.30.Cq; for dark matter, see</i> <i>95.35.+d; for superclusters and</i> <i>large-scale structure of the</i> <i>Universe, see 98.65.Dx</i> )
98.58.Ge	H I regions and 21-cm lines; diffuse, translucent, and high- velocity clouds	98.62.Ra	Intergalactic matter; quasar absorption and emission-line systems; Lyman forest ( <i>for quasars,</i> <i>see 98.54.Aj; for intracluster</i> <i>matter see 98.65.Hb</i> )	98.80.Bp	Origin and formation of the Universe
98.58.Hf	H II regions; emission and reflection nebulae	98.62.Sb	Gravitational lenses and luminous arcs ( <i>see also 95.30.Sf</i> <i>Relativity and</i> <i>gravitation in fundamental aspects</i> <i>of astrophysics and section 04</i> <i>General relativity and gravitation</i> )	98.80.Cq	Particle-theory and field-theory models of the early Universe (including cosmic pancakes, cosmic strings, chaotic phenomena, inflationary universe, etc.) ( <i>see also</i> <i>11.25.—w</i> <i>Strings and branes, and</i> <i>11.10.—z</i> <i>in general theory of fields</i> <i>and particles</i> )
98.58.Jg	Infrared emission	98.62.Tc	Astrometry; identification	98.80.Es	Observational cosmology (including Hubble constant, distance scale, cosmological constant, early Universe, etc)
98.58.Kh	Intercloud medium (ICM); hot and highly ionized gas; bubbles	98.62.Ve	Statistical and correlative studies of properties (luminosity and mass functions; mass-to-light ratio; Tully- Fisher relation, etc.)	98.80.Ft	Origin, formation, and abundances of the elements ( <i>see also 26.35.+c</i> <i>Big Bang nucleosynthesis in nuclear</i> <i>astrophysics</i> )
98.58.Li	Planetary nebulae ( <i>for nuclei of</i> <i>planetary nebulae, see also</i> <i>97.20.Rp</i> )	<b>98.65.—r</b>	<b>Galaxy groups, clusters, and superclusters; large scale structure of the Universe</b>	98.80.Jk	Mathematical and relativistic aspects of cosmology
98.58.Mj	Supernova remnants	98.65.At	Interacting galaxies; galaxy pairs, and triples	98.80.Qc	Quantum cosmology ( <i>see also</i> <i>04.60.—m</i> <i>Quantum gravity in</i> <i>general relativity and gravitation</i> )
98.58.Nk	Tidal tails; H I shells	98.65.Bv	Small and compact galaxy groups	<b>98.90.+s</b>	<b>Other topics on stellar systems; interstellar medium; galactic and extragalactic objects and systems; the Universe (restricted to new topics in section 98)</b>
<b>98.62.—g</b>	<b>Characteristics and properties of external galaxies and extragalactic objects</b> ( <i>for the Milky Way, see</i> <i>98.35.—a</i> )	98.65.Cw	Galaxy clusters	<b>99.10.—x</b>	<b>Errata and other corrections</b>
98.62.Ai	Origin, formation, evolution, age, and star formation	98.65.Dx	Superclusters; large-scale structure of the Universe (including voids, pancakes, great wall, etc.)	99.10.Cd	Errata
98.62.Bj	Chemical composition and chemical evolution	98.65.Fz	Galaxy mergers, collisions, and tidal interactions	99.10.Fg	Publisher's note
98.62.Ck	Masses and mass distribution	98.65.Hb	Intracluster matter; cooling flows	99.10.Jk	Corrected article
98.62.Dm	Kinematics, dynamics, and rotation	<b>98.70.—f</b>	<b>Unidentified sources of radiation outside the Solar System</b>		
98.62.En	Electric and magnetic fields	98.70.Dk	Radio sources		
98.62.Gq	Galactic halos	· · · ·	<i>Quasars, see 98.54.Aj</i>		
98.62.Hr	Spiral arms and bars; galactic disks	98.70.Lt	IR sources ( <i>for IR sources in</i> <i>interstellar medium, see 98.38.Jw</i> <i>and/or 98.58.Jg</i> )		
98.62.Js	Galactic nuclei (including black holes), circumnuclear matter, and bulges ( <i>see also 04.70.—s</i> <i>Physics of black holes in general relativity</i> <i>and gravitation</i> )	98.70.Qy	X-ray sources; X-ray bursts ( <i>see</i> <i>also 97.30.Qt</i> <i>Novae, dwarf novae,</i> <i>97.80.Jp</i> <i>X-ray binaries</i> )		
98.62.Lv	Stellar content and populations; radii; morphology and overall structure	98.70.Rz	$\gamma$ -ray sources; $\gamma$ -ray bursts		
98.62.Mw	Infll, accretion, and accretion disks ( <i>see also 04.70.—s</i> <i>Physics of</i> <i>black holes in general relativity and</i> <i>gravitation</i> )	98.70.Sa	Cosmic rays (including sources, origin, acceleration, and interactions) ( <i>see also 26.40.+r</i> <i>Cosmic ray nucleosynthesis in</i> <i>nuclear astrophysics</i> )		
98.62.Nx	Jets and bursts; galactic winds and fountains				
98.62.Py	Distances, redshifts, radial velocities; spatial distribution of				