**Field Combination Dynamics of High-Energy Photon Interactions with Celestial Bodies: A Wavefunction Instability Model Based on Inelastic Scattering Cross-Sections**

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**Abstract:**Based on Li Zhijun’s Field Combination Wavefunction Theory, this paper constructs a mathematically self-consistent model to describe the microscopic mechanism of high-energy photons tearing apart celestial bodies. The core model formulates the stability of celestial matter as a bound-state eigenvalue problem of the atomic nucleus and electron field combination wavefunctions, while the action of high-energy photons is treated as a time-dependent perturbation. By calculating the interaction Hamiltonian between the high-energy photon field combination and the matter field combination , and its corresponding scattering cross-section , we quantitatively describe the probability of “wavefunction tearing” leading to photodisintegration of atomic nuclei and atomic ionization. The model demonstrates that when the photon energy exceeds a specific threshold and the flux is sufficiently high, the rate of destruction of the matter field combination structure will exceed its recombination rate, leading to the collapse of the celestial body’s macroscopic structure.

**Keywords:** Field Combination Theory; Interaction Hamiltonian; Scattering Cross-Section; Wavefunction Collapse; Photodisintegration; Ionization Cross-Section

1. **Introduction**
2. **Theoretical Framework: Mathematical Models of Stability, Perturbation, and Instability**

**2.1 Field Combination Eigenvalue Problem for Celestial Matter Stability**

The stable state of an atom (using hydrogen as an example) is the solution to the stationary Schrödinger equation for its field combination wavefunction (the direct product of proton and electron field combinations) under electromagnetic interaction (originating from the A-field):

where is the unperturbed Hamiltonian, including kinetic energy and Coulomb potential terms . corresponds to bound states, whose wavefunction is localized in space. Stability means residing in the lowest energy eigenstate.

**2.2 High-Energy Photons as Time-Dependent Perturbations**

A high-energy photon with energy , whose field combination wavefunction is , can be treated as a time-dependent perturbation acting on . The essence of the interaction is the coupling between the photon’s A-field and the electron’s A-field and the atomic nucleus.

**2.3 Mathematical Definition of “Tearing”: Ionization and Disintegration Cross-Sections**

“Tearing” corresponds to a quantum transition of the system from a bound state to a continuum state . Its probability is given by Fermi’s Golden Rule:

where is the density of final states. This transition rate is directly related to the physical scattering cross-section :

* For the atomic level, is the photoionization cross-section.
* For the nuclear level, is the photoneutron emission cross-section.

The macroscopic manifestation of “tearing” corresponds to the statistical result of these microscopic scattering cross-sections over a large number of particles.

1. **Core Mathematical Model: Quantitative Description of the Tearing Mechanism**

**3.1 Atomic Level Tearing Model: High-Energy Photoelectric Effect**

Considering a high-energy photon ionizing a K-shell electron. Its differential cross-section can be approximated by the relativistic Sauter formula:

* : Atomic number
* : Fine structure constant
* : Classical electron radius
* : Ejected electron velocity
* : Ejection angles of the electron

Key point: When , the cross-section . Although the cross-section decreases with increasing energy, each photon transfers more energy to the electron, resulting in greater destructive power.

**3.2 Nuclear Level Tearing Model: Giant Dipole Resonance and Photodisintegration**

The collective excitation of the nucleus can be described by the Giant Dipole Resonance model. The photodisintegration cross-section peaks near the resonance energy and can be described by the Breit-Wigner formula:

* ( is the mass number)
* : Resonance width (typically a few MeV)
* : Maximum cross-section

When , the photon has a high probability of “tearing” the nucleus into an excited daughter nucleus and a neutron.

**3.3 Macroscopic Energy Deposition and Instability Criterion**

Let the high-energy photon flux density be (photons/cm²/s). The rate R at which nuclei are torn apart per unit volume is:

where is the number density of atomic nuclei.

The instability criterion for the celestial structure is that the energy deposition rate exceeds its structural recombination or heat dissipation rate.

The energy deposition rate is:

where is the average energy deposited per interaction (e.g., nuclear disintegration energy, electron kinetic energy).

When (cooling rate), the temperature of the celestial body rises sharply, pressure balance is broken, leading to macroscopic tearing.

1. **Numerical Simulation and Discussion**

By substituting typical parameters (e.g., , , iron nucleus ), it can be calculated that in extreme events (such as gamma-ray bursts), the surface material of a celestial body can be completely ionized and its elemental composition altered within a very short time, leading to catastrophic consequences.

1. **Conclusion**

The mathematical model constructed in this paper shows that the “tearing” of celestial bodies by high-energy photons is essentially a scattering process governed by the fundamental rules of quantum mechanics and is quantifiable. By calculating interaction cross-sections and energy deposition rates, we can accurately predict the stability limits of celestial structures under extreme radiation fields. This provides a solid theoretical foundation for understanding the impact of ultra-high-energy astrophysical phenomena such as gamma-ray bursts and active galactic nuclei on their surrounding environments.

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