Cecilia Lunardini

Curriculum Vitae

Personal data

Born in Piacenza, Italy

Nationality: Italian

Alien status (USA only): currently in the US on a H1B visa

languages spoken: Italian (mother tongue), English

professional address:
Institute for Nuclear Theory
University of Washington
Seattle, WA 98195
Box # 351550
USA

Homepage and websites:

http://www.int.washington.edu/users/lunardi/ (Homepage)

http://neutrinoastro.blogspot.com/ (Neutrino astrophysics literature)

Education and Career

1993-1997 Undergraduate studies in Physics at University of Pavia, Italy.

1996-1997 Working as Tutor of the students of the first year undergraduate course in Physics at University of Pavia.

03/27/1998 Degree in Physics at University of Pavia with mark 110/110 *cum Laude*. Title of the thesis (in italian): "Exclusive generation of photons in Quantum Electrodynamics"; supervisor Dr. O. Nicrosini.

October 1998 Applicant for PhD to SISSA-ISAS, Trieste, Italy. Accepted in the High Energy Physics sector as most successful candidate after entrance examination (mark 98/100).

1998-2001 PhD student in SISSA-ISAS, Trieste, Italy. Research work in neutrino physics and astrophysics under the supervision of prof. A. Yu. Smirnov (ICTP, Trieste).

19/10/2001 PhD degree at SISSA-ISAS. Title of the thesis: "Matter effects on conversion of neutrinos from supernovae and cosmological sources"; adviser: A. Yu. Smirnov (ICTP, Trieste); external adviser: prof. G. Raffelt (MPI, Munich, Germany).

September 2001 - August 2004 Post-doctoral fellowship at the Institute for Advanced Study (IAS), School of Natural Sciences, Princeton. Funds from the National Science Foundation (NSF) and the Keck Foundation.

September 2004 - August 2007 Five years fellow at the Institute for Nuclear Theory of Seattle *and* research assistant professor at the Physics Department of the University of Washington, Seattle.

Awards and other recognitions

January 2003: *Prize "Giorgio Gamberini"* issued by Scuola Normale in Pisa (Italy) for a PhD thesis in Theoretical Physics.

December 2006: Selected as *plenary speaker for the major conference "Neutrino 2006"* (XXII International Conference on Neutrino Physics and Astrophysics) in Santa Fe, New Mexico from June 13-19, 2006.

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Scientific activity

Past and present research: summary

I am mostly known for my work on neutrinos from core collapse supernovae, which constitutes the core of my research.

In this area I have published detailed studies of the effects of neutrino flavor conversion (oscillations) on supernova neutrinos. Some of these works addressed the question of what will be possible to learn from a future galactic supernova. Other papers instead focused on the interpretation of the only supernova neutrino data currently available, those from SN1987A. A common theme in my results is the fact that neutrino oscillations must be taken into account and accurately modeled to be able to extract information from the data on the neutrino spectrum at the production site in the star. Vice-versa, if the original neutrino spectra are known, supernova neutrinos become very sensitive probes of oscillation effects. They allow to study the ordering (hierarchy) of the neutrino mass spectrum and of the small mixing angle θ_{13}, both of which are still unknown. My work also stressed the possibility to use neutrinos, and neutrino oscillations, to probe certain stages of core collapse, such as the formation and propagation of the shock wave that is believed to drive the explosion of the star.

Recently, I have studied the diffuse flux of supernova neutrinos, which is likely to be observed at next generation neutrino detectors of megaton scale. Two results are especially interesting. The first is a new calculation of the electron antineutrino component of this flux in the detectable energy interval, obtained using a neutrino spectrum motivated by SN1987A instead than the output of numerical calculations of neutrino transport. The results are compatible with those of other methods, but favor lower values of the flux, as a consequence of the softer neutrino spectrum favored by SN1987A. A second conclusion of my work is a new upper limit on the electron neutrino component of the diffuse flux using the data on antineutrinos from SuperKamiokande and neutrino oscillations. This new, indirect, limit is the strongest existing at the moment, improving by about an order of magnitude on the recent direct bound from the Sudbury Neutrino Observatory (SNO). My research on the diffuse supernova neutrino flux is ongoing. Currently, the attention is on the dependence

of this flux on the supernova population of the universe (cosmological supernova rate, mass distribution of supernova progenitors, etc.).

A different subject of my research has been the neutrino-neutrino interaction and its effects on neutrino flavor conversion in the early universe and in the core of supernovae. Among the conclusions, one had a certain resonance: the fact that in the cosmological (relic) neutrino gas possible neutrino-antineutrino asymmetries generated in the muon or tau flavors would be distributed equally among the neutrino flavors before the epoch of Big Bang Nucleosynthesis. This result was used to exclude the scenario of "degenerate nucleosynthesis", that relied on unevenly distributed asymmetries.

As a parallel line of research, I worked on constraining neutrino non-standard interactions (NSI) with matter using the data from neutrino oscillations experiments. These are sensitive to the contributions of the NSI to the neutrino refraction potential in matter. Therefore the bounds they give on the NSI couplings are complementary to those obtained from neutrino cross section measurements, and represent a reference in the planning of future experiments of neutrino scattering.

Currently, I am in the initial stage of a project whose goal is to update and improve the calculation of the cross section of neutrino interactions on nuclei, for applications to nuclear astrophysics. So far, the activity has been focused on developing new computational tools (see section about research plans for the future).

Publications (conference proceedings not included)

1) **The Minimum width condition for neutrino conversion in matter.**
By C. Lunardini (SISSA, Trieste & INFN, Trieste), A.Yu. Smirnov (ICTP, Trieste & Moscow, INR). SISSA-13-00-EP, Feb 2000. 34pp.
Published in **Nucl.Phys.B583:260-290,2000**
e-Print Archive: **hep-ph/0002152**

2) **Large angle Bhabha scattering and luminosity at DAPHNE.**
By C.M. Carloni Calame (Pavia U. & INFN, Pavia), C. Lunardini (SISSA, Trieste & INFN, Trieste), G. Montagna (Pavia U. & INFN, Pavia), O. Nicrosini, F. Piccinini (INFN, Pavia & Pavia U.). FNT-T-2000-05, SISSA-28-2000-EP, Mar 2000. 24pp.
Published in **Nucl.Phys.B584:459-479,2000**
e-Print Archive: **hep-ph/0003268**

3) **Neutrinos from SN1987A, earth matter effects and the LMA solution of the**

solar neutrino problem.
By C. Lunardini (SISSA, Trieste & INFN, Trieste), A.Yu. Smirnov (ICTP, Trieste & Moscow, INR). Sep 2000. 15pp.
Published in **Phys.Rev.D63:073009,2001**
e-Print Archive: **hep-ph/0009356**

4) **High-energy neutrino conversion and the lepton asymmetry in the universe**
By C. Lunardini (SISSA, Trieste & INFN, Trieste), A.Yu. Smirnov (ICTP, Trieste & Moscow, INR). Dec 2000. 34pp.
Published in **Phys.Rev.D64:073006,2001**
e-Print Archive: **hep-ph/0012056**

5) **Supernova neutrinos: Earth matter effects and neutrino mass spectrum.**
By C. Lunardini (SISSA, Trieste & INFN, Trieste), A.Yu. Smirnov (ICTP, Trieste & Moscow, INR). Jun 2001. 54pp.
Published in **Nucl.Phys.B616:307-348,2001**
e-Print Archive: **hep-ph/0106149**

6) **Supernova neutrinos: Difference of muon-neutrino - tau-neutrino fluxes and conversion effects.**
By Evgeny K. Akhmedov (CFIF, Lisbon & Lisbon, IST), Cecilia Lunardini (Princeton, Inst. Advanced Study), Alexei Yu. Smirnov (ICTP, Trieste & Moscow, INR). Apr 2002. 35pp.
Published in **Nucl.Phys.B643:339-366,2002**
e-Print Archive: **hep-ph/0204091**

7) **Probing the neutrino mass hierarchy and the 13 mixing with supernovae.**
By Cecilia Lunardini (Princeton, Inst. Advanced Study & Santa Barbara, KITP), Alexei Yu. Smirnov (ICTP, Trieste & Moscow, INR). NSF-KITP-03-12, Feb 2003. 57pp.
Published in **JCAP 0306:009,2003**
e-Print Archive: **hep-ph/0302033**

8) **Neutrino flavor conversion in a neutrino background: Single particle versus multiparticle description.**
By Alexander Friedland (Los Alamos & Princeton, Inst. Advanced Study), Cecilia Lunardini (Princeton, Inst. Advanced Study). LA-UR-03-2162, NSF-KITP-03-20, Apr 2003. 12pp.
Published in **Phys.Rev.D68:013007,2003**
e-Print Archive: **hep-ph/0304055**

9) **Do many particle neutrino interactions cause a novel coherent effect?**
By Alexander Friedland (Los Alamos), Cecilia Lunardini (Princeton, Inst. Advanced Study). LA-UR-03-3847, Jul 2003. 24pp.
Published in **JHEP 0310:043,2003**
e-Print Archive: **hep-ph/0307140**

10) **Neutrinos from SN1987A: Flavor conversion and interpretation of results.**
By Cecilia Lunardini (Princeton, Inst. Advanced Study), Alexei Yu. Smirnov (ICTP, Trieste & Moscow, INR),. Feb 2004. 29pp.
Published in **Astropart.Phys.21:703-720,2004**
e-Print Archive: **hep-ph/0402128**

11) **Solar neutrinos as probes of neutrino matter interactions.**
By Alexander Friedland (Los Alamos), Cecilia Lunardini, Carlos Pena-Garay (Princeton, Inst. Advanced Study),. LA-UR-04-1159, Feb 2004. 6pp.
Published in **Phys.Lett.B594:347,2004**
e-Print Archive: **hep-ph/0402266**

12) **Atmospheric neutrinos as probes of neutrino-matter interactions.**
By Alexander Friedland (Los Alamos), Cecilia Lunardini (Princeton, Inst. Advanced Study), Michele Maltoni (SUNY, Stony Brook),. LA-UR-04-5646, YITP-SB-04-43, Aug 2004. 4pp.
Published in **Phys.Rev.D70:111301,2004 (Rapid Communications)**
e-Print Archive: **hep-ph/0408264**.

13) **A Test of tau neutrino interactions with atmospheric neutrinos and K2K.**
By Alexander Friedland (Los Alamos), Cecilia Lunardini (Washington U., Seattle),. LA-UR-05-3140, Jun 2005. 18pp.
Published in **Phys.Rev.D72:053009,2005**.
e-Print Archive: **hep-ph/0506143**

14) **The diffuse supernova neutrino flux, supernova rate and SN1987A.**
By Cecilia Lunardini (Washington U., Seattle), Sep 2005. 15pp.
e-Print Archive: **astro-ph/0509233**, In press in **Astroparticle Physics**.

15) **The Diffuse neutrino flux from supernovae: Upper limit on the electron neutrino component from the non-observation of antineutrinos at superkamiokande.**
By Cecilia Lunardini (Washington U., Seattle),. Jan 2006. 4pp.
Published in **Phys.Rev.D73:083009,2006**.
e-Print Archive: **hep-ph/0601054**

16) **Two modes of searching for new neutrino interactions at MINOS.**
By Alexander Friedland (Los Alamos) , Cecilia Lunardini (Washington U., Seattle) . LA-UR-06-3973, Jun 2006. 10pp. e-Print Archive: **hep-ph/0606101**,
Accepted for publication in **Physical Review D**.

Referee work

Working as referee for:

Physical Review Letters,
Physical Review D,
Physics Letters B,
Astroparticle Physics,
Journal of Physics G,
Journal of Cosmology and Astroparticle Physics (JCAP).

Organizational activities, committee work, etc.

Proposed (jointly with other postdocs) and organized the series of *"Particle Phenomenology Meetings"* at the Institute for Advanced Study, Princeton, during the years 2002-2003 and 2003-2004. For more details, see http://www.sns.ias.edu/ lunardi/phenomeetings1.htm .

Proposer and organizer of the series of *"Neutrino Meetings"* , a joint initiative of INT and of the physics department of the University of Washington. The series started in the summer of 2005 and is ongoing. For more details, see http://www.int.washington.edu/users/lunardi/.

Fall 2004: joined the *TeraScale supernova initiative* (see url: http://www.phy.ornl.gov/tsi/).

Invited member of the *theoretical advisory committee of the UNO* (Underground Nucleon decay and Neutrino Observatory) project (coordinator Chang Kee Jung, SUNY Stony Brook, see http://ale.physics.sunysb.edu/uno/)

Member of the *APS Neutrino Study* working group on "Neutrino Astrophysics and Cosmology". Coauthor of the related summary report paper, hep-ph/0412544 (see url: http://www.aps.org/neutrino).

Co-organizer of the *workshop "Physics and Henderson DUSEL"*, in Fort Collins, CO, 11/18-

11/19 2005, see url http://hep45.hep.colostate.edu/ wilson/DUSEL/ TopicalWorkshops/Physics-WorkshopNov05.html).

Member of the local organizing committee of the *conference NNN-06* (Next generation Nucleon decay and Neutrino detectors), to take place in Seattle, 9/21-9/23/2006).

Keeping a *internet page (blog) of Neutrino Astrophysics Literature*: http://neutrinoastro.blogspot.com/.

Teaching and mentoring

Invited lecturer at the New England sections of the *American Physical Society and American Association of Physics Teachers*, held at the Phillips Exeter Academy, Exeter, New Hampshire, on March 26 and 27 2004. Talk given: "Neutrinos from the Sun". See url: http://science.exeter.edu/NESAAPT_NESAPS/index.htm.

Invited special lecturer at the *Princeton Summer School* for italian high school students, organized by C.R. Nappi (Princeton University). Talk given: "I neutrini e il sole" ("Neutrinos and the sun", in italian, see url: http://www.lngs.infn.it/lngs_infn/index.htm?mainRecord= http://www.lngs.infn.it/lngs_infn/contents/lngs_en/public/educational/initiatives/princeton.htm).

Taught a reading class on *"CP-violation and neutrino oscillations"* in the Physics Department of the University of Washington for the year 2004-2005. Student E. Thrane (UW graduate program).

Participated in the UW *Physics Recruitment Weekend,* a weekend of meetings between UW faculty members and perspective graduate students, March 4 - 5 2005.

Worked on a summer project on *"Gravitational clustering of neutrinos"* with a UW graduate student, B. Feldman, summer 2005.

Led an independent study on *"Instantons and sphalerons"*, students E. Thrane and K. Shiraishi (UW graduate program), summer 2005.

Occasionally substituted for W.Haxton in *teaching the course "Nuclear Astrophysics"* at the University of Washington, fall 2005.

Serving in the *reading committee* of the PhD defense of Kiyoshi K. Shiraishi, University of

Washington (08/11/2006, advisor: R. Jeffrey Wilkes).

Conferences and Workshops

35th Rencontres De Moriond: Electroweak Interactions And Unified Theories 11-18 Mar 2000, Les Arcs, France

Talk given: "The minimum width condition for neutrino conversion in Matter".

11th International Seminar On High-Energy Physics (Quarks 2000) 13-21 May 2000, Pushkin, Russia

Talk given: "Neutrino across the Universe".

19th International Conference On Neutrino Physics And Astrophysics - Neutrino 2000 16-21 Jun 2000, Sudbury, Ontario, Canada

Contributed paper: "Neutrino across the Universe".

EURESCO Conference On Frontiers In Particle Astrophysics And Cosmology 30 Sep - 5 Oct 2000, San Feliu de Guixols, Spain

Talk given: "Neutrinos from SN1987A, LMA and Earth matter effects ".

Physics Potential of Supernova II Neutrino Detection, 15-16 Feb. 2001, Marina del Rey, California, USA

Talk given: "Earth matter effects on supernova neutrinos".

APS / DPF / DPB Summer Study On The Future Of Particle Physics (Snowmass 2001), 30 Jun - 21 Jul 2001, Snowmass, Colorado

NO-VE International Workshop On Neutrino Oscillations In Venice, 24-26 Jul 2001, Venice, Italy

Talk given: "Supernova neutrinos: Earth matter effects and the neutrino mass spectrum".

EuroConference On Neutrinos Masses And Mixings, 30 Jul - 31 Aug 2001, Les Houches, France

Talk given: "High-energy neutrino conversion and the lepton asymmetry in the Universe"

PHENO 2002 Symposium, 22-24 Apr 2002, Madison, Wisconsin

Talk given: "Supernova neutrinos and the reconstruction of the nu oscillation parameters"

20th International Conference On Neutrino Physics And Astrophysics (Neutrino 2002), 25-30 May 2002, Munich, Germany

Poster presented: "Supernova Neutrinos and the Reconstruction of the Neutrino Oscillation Parameters "

Neutrinos And Implications For Physics Beyond The Standard Model, 11-13 Oct 2002, Stony Brook, New York

Workshop On Neutrino News From The Lab And The Cosmos, 17-19 Oct 2002, Batavia, Illinois

Talk given: "The Physics Potential of Neutrinos from Supernovae "

KITP Program "Neutrinos: Data, Cosmos, and Planck Scale", Jan 13 2003 - February 09 2003, KITP, Santa Barbara, California

Talk given: "Probing the Neutrino Mass Hierarchy and 1-3 Mixing with Supernova Neutrinos "

4th Workshop On Neutrino Oscillations And Their Origin (NOON2003), 10-14 Feb 2003, Kanazawa, Japan

Talk given: "Neutrino Flavor conversion inside and outside a supernova"

Conference On Neutrinos: Data, Cosmos And Planck Scale, 3-7 Mar 2003, KITP, Santa Barbara, California

Talk given: "Neutrino mixing and the supernova neutrino signal"

11th Annual International Conference On Supersymmetry And The Unification Of Fundamental Interactions (SUSY 2003), 5-10 Jun 2003, Tucson, Arizona

Talk given: "Physics of supernova neutrinos: flavor conversion effects"

8th International Workshop On Topics In Astroparticle And Underground Physics (TAUP 2003), 5-9 Sep 2003, Seattle, Washington

Talk given: "Neutrino Oscillations and Many Particle Neutrino Interactions"

2004 Phenomenology Symposium (PHENO 04) 26-28 Apr 2004, Madison, Wisconsin

Talk given: "Solar neutrinos as probes of neutrino-matter interactions"

Open Issues in Understanding Core Collapse Supernovae Institute for Nuclear Theory, Seattle, June 22 - 24, 2004

Talk given: "Neutrino Physics with Supernovae "

Aspen Summer Workshop On Lepton Number Violation: Neutrinos, Leptogenesis, Grand Unified Theories And Beyond, 28 Jun - 18 Jul 2004, Aspen, Colorado

International conference on Weak Interactions and Neutrinos (WIN2005) Delphi, Greece, June 6th - 11th 2005.
Talk given: "Non-standard neutrino-matter interactions".

Santa Fe summer workshop on **Implications of Neutrino Flavor Oscillations (INFO 2005)**, Santa Fe, New Mexico, USA, July 11 - July 15, 2005. Talk given: "Neutrino Oscillations and Non-Standard Neutrino-Matter Interactions"

Santa Fe summer workshop on **Physics and Astrophysics of Supernova Neutrinos (PASN 2005)**, Santa Fe, New Mexico, USA, July 18 - July 22, 2005. Talk given: "The diffuse supernova neutrino flux: sensitivity goals of future searches"

UltraMini Workshop on Cosmology and Astrophysics, University of Oregon, Eugene, 22-26 May 2006. Talk given: " Studying Core Collapse Supernovae with Neutrinos".

Neutrino 2006 (XXII International Conference on Neutrino Physics and Astrophysics) in Santa Fe, New Mexico from June 13-19, 2006. Talk given: "Diffuse supernova neutrinos"

Neutrino Oscillation Workshop 2006 (NOW2006), Conca Specchiulla, Italy, 9 to 16 September 2006. Talk given: "Diffuse Supernova Neutrino flux"

Workshop on Next generation Nucleon decay and Neutrino detectors 2006 (NNN06), September 21 to 23, 2006 University of Washington, Seattle, WA, USA. Organizer and convener of parallel session on astropysical neutrinos.

Cecilia Lunardini

Professional plans

Research philosophy and interests

In my research activity I try to focus on problems that I believe are timely and important, and study them in depth. I value team work, and I am happy to absorb ideas from the environment. Therefore I would like to join a group that values collaboration between its members, or contribute to create one if the necessary resources are available. I enjoy communication at my workplace and at scientific events, and I like to give talks, both technical and, occasionally, popular. I am interested in the interaction with students and postdocs, which I find stimulating. I think I would be a good teacher and mentor.

As for my scientific interests, I would like to expand and deepen my research in the field of *nuclear and particle astrophysics*, with a phenomenological perspective. I plan to concentrate my activity on the effects of fundamental physics in astrophysical sites, and in particular supernovae and the early universe, with possible interest in cosmic rays and in solar neutrinos. I particularly enjoy studying the potential implications of new subatomic physics on astrophysical phenomena. The contact with existing or upcoming experimental data is my main focus, and therefore I tend to fit well in institutions that have both a theoretical and an experimental program, and are interested in members that can bridge the two areas. I would welcome the opportunity to collaborate with groups working on numerical projects, like, for example, the simulation of core collapse supernovae.

Research program

My research plans for the future tend to be flexible, as they are meant to adjust to follow the evolution of the field. A likely scenario is summarized schematically in Table 1. It includes both the expansion of existing lines of research (see section on past and current research), and the opening of new areas of work.

Below I discuss the items that have higher priority at the moment.

- **Neutrinos and supernovae**
  This is my main area of expertise. I plan to continue my work on the physics potential of future neutrino observations. Specifically, I intend to study what physics of neutrinos and of supernovae can be learnt from future detections of neutrinos from core collapse. This is relevant to motivate and guide experimental work, as well as to lay the foundation of neutrino astrophysics of supernovae. The latter will develop rapidly once data become available and are recorded continously in time. This will happen with the next generation of water Cerenkov neutrino detectors: thanks to their megaton volume and/or enhanced neutron tagging efficiency, these will observe the diffuse flux of supernova neutrinos, thus changing the field of supernova neutrinos from very slow moving to rapidly progressing, resembling what happened in the past with the areas of solar and atmospheric neutrinos. The possible new data from an individual galactic supernova would make the scenario even more exciting.

  In the perspective of new data becoming available, it is crucial to improve the theoretical predictions of the observable flux of supernova neutrinos, both diffuse and from an individual star. I plan to work on this, with emphasis on the uncertainties involved. These uncertainties are due to unknowns in the neutrino mixing matrix and mass spectrum, and on the cosmological rate of core collapse supernovae. Whenever possible, I would like to obtain results that do not depend on the connection between supernova rate and star formation rate, which is rather uncertain.

  Recently, I have become interested in the dependences of supernova physics on the features of the progenitor star, such as mass, magnetic field and rotation. I would like to study such dependences and their effects on the neutrino burst. To address the question of whether neutrinos can help to identify the type of supernova progenitor would be very interesting.

- **Neutrino-matter interaction**
  My experience on this subject comes from projects on neutrino non-standard interactions and their effects on neutrino refraction in matter. I plan to continue this line of research, by studying applications to neutrino beams and/or by elaborating on the effects of the exotic interactions in a supernova.

  Currently, I am starting a new project on neutrino-nucleus cross sections. The origin of my interest on this is the need of detailed and precise cross sections for applications to the problems of nucleosynthesis in presence of neutrinos, to the physics of neutrinos in collapsing stars and to neutrino detection. On this, I am in the phase of learning and building the basic skills necessary to make calculations. The learning is possible thanks to the close interaction with Wick Haxton at INT and to the INT program devoted to this subject in the summer of 2006. This project is too preliminary to predict its outcome in detail. The results could range from new computational tools useful for the calculation of cross sections to fully developed calculations of neutrino cross sections on specific nuclei with validity up to ~ 10 GeV of energy, relevant for

neutrino beam experiments.

- **Other nuclear-particle astrophysics**
  While working on the diffuse flux of supernova neutrinos, I have become interested in the cosmological rate of core collapse supernovae (SNR). On this, I have published the results of a global fit of direct measurements of the SNR as a function of the redshift. I plan to extend this work to address a number of open questions. One of these is the issue of the normalization of the SNR, which is largely uncertain due to effects of extinction on supernova observations and due to the uncertainty in the minimum stellar mass necessary for core collapse. The experimental searches of diffuse supernova neutrinos add important information on the normalization, since neutrinos are not affected by extinction. A second question is the contribution to the SNR from the first stars (Population III), potentially very interesting for its implications on star formation. Other questions arise from the comparison of the SNR with the star formation rate. The two quantities are predicted to be proportional, but data are not conclusive on this. A consistent combination of all the different pieces of data on the SNR does not exist and would be very interesting. My expertise on the diffuse supernova neutrino flux could add substantially to a collaboration on this subject.

Teaching philosophy

I enjoy to communicate science, both at the technical and popular level, and I could use this inclination for teaching. I think that a course should first of all be targeted on the learning needs of the students: depending on their career path, these needs may range from being able to understand a newspaper article about science to developing specific skills for a profession in a scientific field, just to give some examples. From my personal experience I know that to learn physics can be important regardless of specific professional applications, as a way to develop logical thinking and problem solving abilities. This would motivate me to teach to non-physics majors as well as to future physicists.

As for the method of teaching, I would follow what I learned during my education and research activity: learning is very much driven by motivation, by experience, and by validation. Accordingly, I would try to find ways to keep the students motivated, for example by emphasizing the contact of what they learn with the real world of research in physics and engineering. I would also encourage hands-on approaches, with the use of simple experiments when possible. The validation of the students' efforts would be important to avoid discouragement, and therefore I would focus more on evaluating what a student knows and is able to achieve rather than on punishing what he/she failed to memorize.

	Neutrinos and Supernovae (SN)	neutrino-matter interaction	other astro-nuclear-particle phenomenology
High priority	- **physics potential of future SN neutrino observations** - **Prediction of SN neutrino fluxes** - physics in specific sub-types of SN (first stars, small mass SN, ..)	- study of neutrino-nucleus cross sections for astrophysical applications	- constraints and/or predictions on the cosmological supernova rate
Medium priority	- **SN neutrino data analysis** - numerical study of neutrino propagation in dense matter	- **phenomenology and data analysis of ν-matter interaction tests**	- production and propagation of weakly interacting particles in astrophysical settings (high energy ν, sterile neutrinos, axions, etc.) - effects of neutrino properties in cosmology (mass, interactions, etc.)
Lower priority			- Underground science for astroparticle experiments

Table 1: Schematic view of my research plans, divided by topic and level of priority. In bold are the items where I have the highest expertise from previous work. Priorities may change over time depending on specific events (e.g., new supernova neutrino data) or on the contact with other researchers in the field.