Pavel Denisenkov

Carriculum Vitae

Education and Degrees

1998–2001 **Doctor of Science (Habilitation) in Astrophysics**, *St. Petersburg State University*, Russia, *awarded unanimously*.
Thesis title: "Deep Mixing in Globular-Cluster Red Giants" [17].

1986–1990 **Candidate of Science (PhD) in Astrophysics**, *Leningrad State University*, USSR, *awarded unanimously*.
Thesis title: "A Study of Some Chemical Peculiarities in Stars on the Basis of the Stellar Evolution Theory". The main conclusion of that work was that Na should be added to those few elements whose abundances significantly change during H burning in stars, and therefore the surface [Na/Fe] abundance ratio can be used to constrain thermodynamic and mixing conditions in stellar interiors [13, 3, 8, 11, 10]. At present, most stellar spectroscopy studies include [Na/Fe] in their abundance measurements.

1978–1983 **Master of Science in Astronomy**, *Leningrad State University*, USSR, *with honors*.
Thesis title: "Global Physical Characteristics of White-Dwarf Model Stars" [1].

Languages

English	Fluent	*7 years of teaching and ∼25 years of giving talks and writing papers in English*
Russian	Native	
German	Good	*lived and worked (in the MPI for Astrophysics, Garching) in Germany for ∼3 years*

Computer skills

programming languages	Fortran, Python	commercial software	Matlab, Comsol
research software	MESA, NuGrid	other software	LaTeX, Keynote, MS PowerPoint, Excel, Word

Teaching Experience

Teaching as a sessional instructor at the University of Victoria since 2012

Graduate Courses "Classical Electrodynamics" (PHYS 502A), "Stellar Populations" (ASTR 506)

Undergraduate Courses "Introduction to Stellar Astrophysics" (ASTR 404), "Electromagnetic Theory" (PHYS 422)

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Research Experience

Details are provided only for the most important achievements in 2010–2018

07/2010– present **Senior Research Associate**, *with Prof. Falk Herwig*, Department of Physics and Astronomy, University of Victoria, Canada.

Studied nucleosynthesis and mixing in accreting CO and ONe white dwarfs using the MESA stellar evolution and the NuGrid post-processing nucleosynthesis codes.
Detailed achievements:

- Modelled the multi-cycle evolution and convective boundary mixing in CO novae [28];
  - found that the exponentially decaying convective boundary mixing with a length scale of ~ 0.008 pressure scale height can explain the observed heavy-element enrichment of nova ejecta;
  - found that in slowly-accreting cold CO and ONe white dwarfs convection is first triggered by the ignition of freshly synthesized ^{3}He.
- Modelled nucleosynthesis in CO and ONe novae [42];
  - compared the chemical composition yields predicted for CO and ONe novae with the abundances observed in nova ejecta and in pre-solar grains;
  - extracted temperature and density evolution profiles from the bottoms of convective envelopes of our nova models and made them publicly available (`https://github.com/NuGrid/NuPPN/tree/master/examples/ppn_nova`); these nova T and ρ trajectories can be (and have already been) used for simple one-zone reaction rate sensitivity studies.
- Explained why convective boundary mixing may quench the propagation of a carbon-burning front toward the center of a CO core in super-AGB stars;
  - proposed and studied the formation of hybrid CONe white dwarfs resulting from the C-flame quenching [29, 5];
  - studied the impact of Urca process and various mixing assumptions in hybrid CONe white dwarfs on their ability to be progenitors of SNe Ia [41].
- Modelled, for the first time, the multi-cycle evolution of rapidly-accreting white dwarfs (RAWDs) with stable H burning intermittent with strong He shell flashes and mass loss;
  - found that at metallicities [Fe/H] > -2 the efficiency of retention of accreted matter by the RAWDs is so low that their masses will unlikely reach the Chandrasekhar limit for them to explode as SNe Ia [27];
  - found that when the He-shell convection approaches the H-rich surface layer in the RAWDs it begins to ingest protons, which triggers the intermediate (i) process of neutron capture, similar to the one proposed to explain the heavy-element abundance anomalies in the post-AGB star Sakurai's object;
  - showed that the i-process nucleosynthesis in the solar-metallicity RAWDs can contribute to the production of the first n-capture peak elements in the Galactic chemical evolution [6], while the i-process nucleosynthesis yields from the RAWDs with [Fe/H] < -2 can surprisingly well fit the heavy-element abundance distributions in the CEMP-r/s stars [14].
- Developed a method that allows to perform one-zone and multi-zone Monte-Carlo simulations for reaction rate uncertainty and sensitivity studies relevant to convective-reactive nucleosynthesis processes in stars, such as the i process in RAWDs, s process in AGB stars, and hot H burning in novae;
  - used this method to study the impact of (n,γ) reaction rate uncertainties on the i-process nucleosynthesis in Sakurai's object [15];
- Adjusted parameters of convective boundary mixing in the MESA code allowing to model the formation of ^{13}C pocket in AGB stars of the right mass $\sim 10^{-4}\,M_{\odot}$, as proposed in [40], with protons being mixed into the He/C-rich zone by small-scale turbulence driven by internal gravity waves [2].

07/2009–05/2018 **Senior Research Associate**, *with Prof. Don VandenBerg*, Department of Physics and Astronomy, University of Victoria, Canada.

Modelled magnetic braking of internal solar rotation, thermohaline mixing in low-mass RGB stars, the evolution of low-mass stars on the horizontal branch, and worked on the problem of the proton-capture abundance anomalies (multiple populations) in globular clusters.
Detailed achievements:

- Used the finite element code Comsol to model magnetic braking of solar rotation in 2D [19];
  - showed that a strong horizontal turbulent viscosity is required, along with magnetic braking, to reproduce the nearly uniform rotation of the solar radiative core.
- Used a spectral code to perform 2D and 3D hydrodynamic simulations of thermohaline mixing in RGB stars [20, 31];
  - found that this mixing is $\sim$50 times as slow as the one required to reproduce the evolutionary depletion of [C/Fe] in low-mass RGB stars.
- Proposed an explanation of why some of the Li-rich red giants are found below the bump luminosity [21].
- Generated a large set of horizontal-branch (HB) models with different metallicities, He mass fractions and initial masses, and wrote an HB population synthesis code that uses these models as input data;
  - used this code, along with the Victoria-Regina isochrones, to estimate distance moduli, [Fe/H] ratios, He abundances, and ages for the globular clusters M 3, M 13, M 15, M 55, M 92, 47 Tuc, and NGC 6362 by fitting their HBs and RR Lyrae periods [56, 46, 57];
  - our distance modulus for 47 Tuc agrees within $\sim$1% with its value recently obtained using a Gaia paralax for this cluster;
  - the HB population synthesis code was also used to transform mean colors of blue HB stars in the Galactic halo to their ages [55, 4].
- Proposed a solution of the 80-year old problem of the Oosterhoff dichotomy for globular clusters, which also constrains the efficiency of RGB mass-loss.
- Proposed that the p-capture abundance anomalies in globular clusters had been produced by H burning in supermassive stars formed in the process of runaway massive star merger during the first few million years of their lives [24].

07/2005–06/2008 **Postdoctoral Researcher**, *with Prof. Marc Pinsonneault*, Department of Astronomy, The Ohio State University, USA.
Publications [37, 32, 34, 33, 35, 36, 38]

07/2004–06/2005 **Research Associate**, *with Prof. Brian Chaboyer*, Department of Physics and Astronomy, Dartmouth College, USA.
Publication [22]

07/2002–06/2004 **Postdoctoral Fellow**, *with Prof. Don VandenBerg*, Department of Physics and Astronomy, University of Victoria, Canada.
Publications [40, 25, 43, 44, 50, 26, 18]

2000–2002 **Senior Research Associate**, Sobolev Astronomical Institute, St. Petersburg State University, Russia.
Publications [58, 48, 39, 49]

1983–2000 **Research Associate**, Sobolev Astronomical Institute, Leningrad/St. Petersburg State University, Russia.
Publications [13, 3, 1, 8, 9, 11, 10, 12, 59, 51, 23, 58, 48, 39]

02/1998–07/1998 **Alexander von Humboldt Fellow**, Max-Planck Institute for Astrophysics, Garching, Germany.
Publication [30]

09/1992–02/1994 **Alexander von Humboldt Fellow**, Max-Planck Institute for Astrophysics, Garching, Germany.
Publications [16, 47]

References

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- **Prof. Hendrik Schatz**, *Email:* schatz@nscl.msu.edu, *Phone:* +1 (517) 908-7397, *Address:* Director, JINA Center for the Evolution of the Elements, National Superconducting Cyclotron Laboratory, Michigan State University, 640 S. Shaw Lane, East Lansing, MI 48824, USA;
- **Prof. Don VandenBerg**, *Email:* vandenbe@uvic.ca, *Phone:* +1 (250) 721-7739, *Address:* Department of Physics and Astronomy, University of Victoria, Elliott Building, Room 101, 3800 Finnerty Road, Victoria, BC, V8P 5C2, Canada;

Publications

[1] K. N. Artemyev and P. A. Denisenkov. Global physical characteristics of white dwarf model stars. *Nauchnye Informatsii*, 65:145, 1988.

[2] U. Battino, M. Pignatari, C. Ritter, F. Herwig, P. Denisenkov, J. W. Den Hartogh, R. Trappitsch, R. Hirschi, B. Freytag, F. Thielemann, and B. Paxton. Application of a Theory and Simulation-based Convective Boundary Mixing Model for AGB Star Evolution and Nucleosynthesis. *ApJ*, 827:30, August 2016.

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more than 2000 citations, h-index: 30

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