Max-Planck-Institut für Sonnensystemforschung

Max Planck Institute for Solar System Research

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Selection Committee
CNRS, France

Re: Recommendation letter for Ms. Anna Kotova

Dear Selection Committee,

I am very pleased to recommend Ms. Anna Kotova as a research scientist for CNRS. I have been working with Anna since April 2012 when she joined the Planetary Plasmas Group (PPG) at the Max Planck Institute for Solar System Research, Germany (MPS), following her selection as a Max Planck Research School doctorate student.

I am a researcher at MPS since the completion of my thesis in 2008, working on various projects and tasks including Cassini (research associate on the MIMI instrument team), JUICE (Co-I on two magnetospheric experiments, PEP and J-MAG), NASA's Europa Clipper (Co-I on the plasma instrument PIMS) and the supervision of doctorate students (https://orcid.org/0000-0002-5699-0678). As part of her thesis, Anna joined the Cassini MIMI team. The MIMI experiment consisted of three different detectors, providing one of the most advanced set of measurements of energetic charged and neutral particles ever returned from the outer planets. Anna's overall task was to develop simulation codes that can enhance the analysis and interpretation of the MIMI observations, and to apply these codes to two different projects, one involving the interaction of Saturn's moons with the planet's magnetosphere while the second focused on the formation of Saturn's radiation belts.

Given the complexity of the project, I have been very positively impressed by the ability of Anna to effectively combine simulations with data analysis, including the development of new simulation tools. Anna demonstrated excellent research skills deriving from her solid background in computer and space science and space engineering. She developed her simulation codes guided by complex observations by two of the three MIMI sensors, despite a series of challenges and difficulties, one being the fact that her supervisors (including myself) have little experience on simulations and numerical methods, another being the extended interruptions of her work for her maternity leave (twice during her scientific career). Anna has contributed to 14 papers as first-author or co-author with leading roles in many of those. By following her work presented in various recent conferences and through the descriptions in her CV, I am aware that several articles are in the works, dealing either with MAVEN observations at Mars or Cassini observations at Saturn.

Anna's research findings are important and fundamental for the development of the research field of planetary magnetospheres and moon-magnetosphere interactions (and beyond that). She used her particle tracing simulation code to accurately reconstruct the energetic ion signal observed by MIMI during several Cassini flybys of Saturn's moons. The successful reconstruction has demonstrated that when charged particle tracers are combined with energetic particle measurements, they comprise excellent tools for probing the magnetic configuration of moon-magnetosphere interaction regions, for inferring the ion composition and ionization state, for the study of magnetospheric dynamics on both local and global scales and for cross-calibrating instruments. Her methodology is now considered fundamental for the study of the jovian moons by the upcoming JUICE and Europa Clipper missions, with numerous follow-up studies, groups or individual researchers using her approach. A research group in the Georgia institute of Technology (Atlanta, USA) (https://svensimon.gatech.edu/research/) has received considerable funding to further develop Anna's reverse particle tracing analysis. The simulation code she developed became the basis for the theses of two more students at MPS, and a fundamental analysis tool for the members of the PPG at

MPS. Energetic particle tracing has now evolved into a standard analysis method for space plasma investigations at the outer planets.

Anna's simulation code has been also used to calculate the Galactic Cosmic Ray (GCR) access to Saturn's rings and atmosphere. Anna was the first to consider the shadowing effect of Saturn's rings and realistic models of the magnetosphere in order to estimate the GCR access efficiency. GCR interactions drive the formation of Saturn's ion radiation belts so her analysis was a necessary and important step towards explaining existing measurements by Cassini and the observations from the highly-anticipated Proximal Orbits in 2017 during which MIMI sampled for the first-time unexplored radiation belt sectors. Indeed, Anna contributed greatly to the analysis of results from Cassini's Proximal Orbits, using her simulation code in order to explain the origin of a new trapped proton population discovered between Saturn and its rings. These results, were published in the journal Science, as mentioned above. She was also one of the lead-coauthors of a Nature Astronomy paper describing the first long-term observations of a planetary radiation belt other than that of the Earth. Her research approach and methodology benefits from the fact that the space environment properties and the geophysical characteristics of a solar system object are strongly coupled. Saturn's rings, for instance, are both responsible for creating and destroying Saturn's radiation belts: knowledge of the ring properties may therefore help us build reliable radiation belt models. The reverse path is also valid: radiation belt measurements can help us constrain properties of the rings not accessible by remote sensing. This strong coupling is not limited to Saturn's rings, but applies to all of our solar system. This is the principle upon which Anna's research plan and long-term goals are built upon in the current proposal.

Anna has also contributed to a review book published by the International Space Science Institute (ISSI) in Bern and has become an integral member of the MIMI team of the Cassini mission. In her Master thesis, she simulated the aspects of moon exospheres, showing that she has a wide range of interest and capabilities, not limited to energetic particle physics. It is no surprise to me that Anna got integrated in a highly competitive team of the MAVEN mission to Mars, despite Mars being a drastically different planetary space environment than that of the outer planets. Anna has also contributed to a White Paper I led about the future exploration of Jupiter's radiation belts in response to ESA's Voyage 2050 call and to a similar submission in response to NSFs ongoing Decadal Survey. The first White Paper has also been restructured into a refereed publication, currently under review for Experimental Astronomy. She is heavily involved in mission design proposals, in specific the DAEDALUS mission to study field aligned currents and the effects of heating Earth's upper atmospheric layers. Anna is clearly not just an expert in her doctoral thesis topic, but a mature researcher who appreciates different research fields and their interconnections.

With the level of expertise that Anna has and the collaborations she has established, Anna will have no problem in handling her proposed research projects that in part rely around a common methodology, which uses particle tracing tools and PIC/MHD simulation codes that Anna has developed and/or is familiar user. That ensures the project's continuity, despite its apparent diversity. The project is backed-up by the participation of Anna and her candidate group to many relevant space missions: Cassini, JUICE, Bepi-Colombo, MAVEN, DAEDALUS such that she is not just focused on small-scale, individual studies, but adjusted also for future observations and unexpected results. Anna's involvement in the MAVEN mission enhanced her data analysis skills, with two pure data-driven papers nearing publication. Anna is also actively involved in ongoing discussions about missions to Uranus and Neptune and is able to direct her research to the preparation of such long-term and large-scale project that will benefit both her and her research institute. Anna's advanced simulation and coding skills enable her to adjust and evolve her research methodology with modern and efficient data analysis tools (e.g. Machine Learning, as described in her proposal).

Finally, I would like to add that it was always a pleasure to work with Anna and I am very glad that I am able to continue my collaboration with her, even after she moved to IRAP. She is very social, reliable and easy to cooperate and communicate. Anna has demonstrated that she can work independently and evolve simple ideas into high-level research projects. She also appreciates team work and knows when it is in the best interest of her and her team to seek solutions through collaboration instead of spending time to develop new, personal capabilities. For all these reasons, I believe that Anna deserves your organization's fellowship. She has the skills, the motivation and the potential to become a leading scientist in her field.

For any inquiries or additional information, do not hesitate to contact me.

Sincerely,

Elias Roussos

Digitally signed by Elias Roussos
Date: 2021.01.06 16:23:28 +01'00'

Dr. Elias Roussos