Understanding energetic particle injections and their effect on Earth's outer radiation belt electrons using multipoint observations

Team Leads: Dr. Drew L. Turner (UCLA) and Dr. Geoff Reeves (LANL)

Abstract

We propose a Space Sciences team to the International Space Science Institute (ISSI) to take advantage of the current, unprecedented level of observational coverage throughout Earth's inner magnetosphere and conduct focused research pertaining to the dynamics of Earth's radiation belts. Specifically, we propose an observationally oriented study to address a set of topical questions in magnetospheric physics concerning the nature of energetic particle injections and their importance in driving outer radiation belt variability. Our team is comprised of outstanding researchers hailing from top institutes based in five different European nations, the United States, Canada, Japan, Korea, and China; all of the members share an expertise on observations of particles and waves in Earth's radiation belts. These members also represent several of the missions providing the data that will serve as the basis for our focused research, namely, NASA's Van Allen Probes and THEMIS missions, ESA's Cluster mission, the BARREL Antarctic balloon campaigns, NSF CubeSats, ground-based observatories, and upcoming missions (e.g., ERG).

1. Scientific Rationale, Goals, and Timeliness

1.1 Introduction

Earth's radiation belts consist of dynamic populations of relativistic particles trapped in the geomagnetic field, and there are still many important outstanding questions concerning the drivers of the extreme variability that is observed primarily in the outer electron belt [e.g., Reeves et al., 2003; Millan and Baker, 2012]. Radiation belt particles (ions and electrons) pose a threat to astronauts and other valuable, unmanned space assets, and thus, understanding the extreme variability of this system has become an international priority, with several countries devoting billions of dollars to space missions and research programs to study the belts. With the recent launch of NASA's Van Allen Probes (acronym RBSP) adding two more points to the existing constellation of spacecraft (e.g., Table 1), we now have an unprecedented level of in situ measurements of energetic particles in Earth's inner magnetosphere that can be used to study the radiation belts. The basic concept of multipoint analysis is that the more points of observation are included from such an enormous and complex system as Earth's radiation belts, the better scientists are able to identify the variety of global and local mechanisms that are driving dynamics throughout the system. An ideal way to conduct a multipoint observational study is to assemble a group of experts on different missions and datasets, identify events of interest on a particular problem, and coherently assemble and analyse the various datasets to address the chosen problem.

Here we propose such a team of international scientists for supported research following the requirements and guidelines of the International Space Science Institute (ISSI). This team (see the roster in section 4 and attached CVs for each member) consists of leading experts in the physics of Earth's radiation belts and inner magnetosphere and the instrumentation and data analysis required to probe and understand these important regions of near-Earth space. Furthermore, several of the team members have roles on each of the key missions used for the proposed studies and are experts on accessing and analysing the data from those observatories (see Table 1 for the observatory list and availabilities). ***We propose that the team meets twice in Bern, Switzerland in 2014 and 2015, with each meeting corresponding to a focused effort on the topic of how energetic particle injections into the inner magnetosphere influence source and loss of relativistic electrons in Earth's outer radiation belt.***

Mission	Observations	Data Availability	Experts from Proposal Team
Cluster (4)	Plasma, fields, particles	2001-Present	Dandouras; Kronberg; Santolik; Taylor
THEMIS (3)	Plasma, fields, particles	02/2007-Present	Bortnik; Hwang; Li; Liu; Turner
Van Allen Probes (RBSP: 2)	Plasma, fields, particles	09/2012 – Present	Bortnik; Li; Reeves; Santolik; Turner; Ukhorskiy
CSSWE	Particles	10/2012 – Present	Li
POES/MetOp (6)	Particles	01/2004 – Present	Clilverd; Hwang; Miyoshi; Turner
GOES (3)	B-field, particles	01/1986 – Present	Li; Miyoshi; Turner
LANL-GEO (6)	Plasma, particles	01/1991 – Present	Reeves
BARREL (*)	B-field, particles*	12/2012 – 02/2013 and 12/2013 – 02/2014	Millan
GBOs (*)	B-field, particles*	Continuous	Clilverd; Donovan

ERG	Plasma, fields, particles	Launch in 2015	Miyoshi

Table 1: Missions with data that will be incorporated into this study. Constellation missions include the number of spacecraft currently available, indicated in parentheses next to the mission name. Types of observations and availability dates are also listed. This proposal team consists of a group of experts versed in the use of data from these various missions, as indicated in the rightmost column. *Ground-based observatories (GBOs) and balloon campaigns consist of many observatories and measure energetic particles indirectly via X-rays or ionospheric absorption.

1.2 Background

Energetic particle injections involve the sudden inward transport of energetic ions and electrons (typically 10s to 100s of keV) from the plasma sheet in Earth's magnetotail into the inner magnetosphere, where the particles become quasi-stably trapped in the ring current and outer radiation belt [e.g., Reeves et al., 1996; Gabrielse et al., 2014 and references therein]. Particles are transported by transient electric fields associated with the dipolarization of Earth's magnetic field following magnetic reconnection in the magnetotail [e.g., Li et al., 2003]. Injections occur regularly (many times per day) and are thought to be important for introducing the "seed population" of electrons into the outer electron radiation belt and the subsequent acceleration of these electrons to relativistic energies (up to several MeV) [e.g., Hwang et al., 2004; Reeves et al., 2013; Turner et al., 2013]. Van Allen Probes data are now revealing the unexpected amount of particle injections that penetrate directly into the heart of the outer belt itself. Particle injections are also considered important for introducing the populations of energetic ions and electrons that contribute to the build-up of the ring current, which can result in geomagnetic storms, and that are responsible for generating various plasma waves, which can then interact with outer radiation belt electrons and contribute to acceleration and loss of those particles [e.g., Millan and Thorne, 2007; Turner et al., 2014]. For these reasons, energetic particle injections are particularly interesting from a scientific standpoint, since they represent cross-energy and –species processes under which acceleration and loss of relativistic electrons are affected by the dynamics of lower energy electrons and various ion species. However, there is currently only limited and/or indirect observational evidence in support of these concepts. Additionally, major outstanding questions remain as to the nature of the injections themselves (e.g., the azimuthal extent and shape of injection fronts), how the upper energy thresholds and penetration

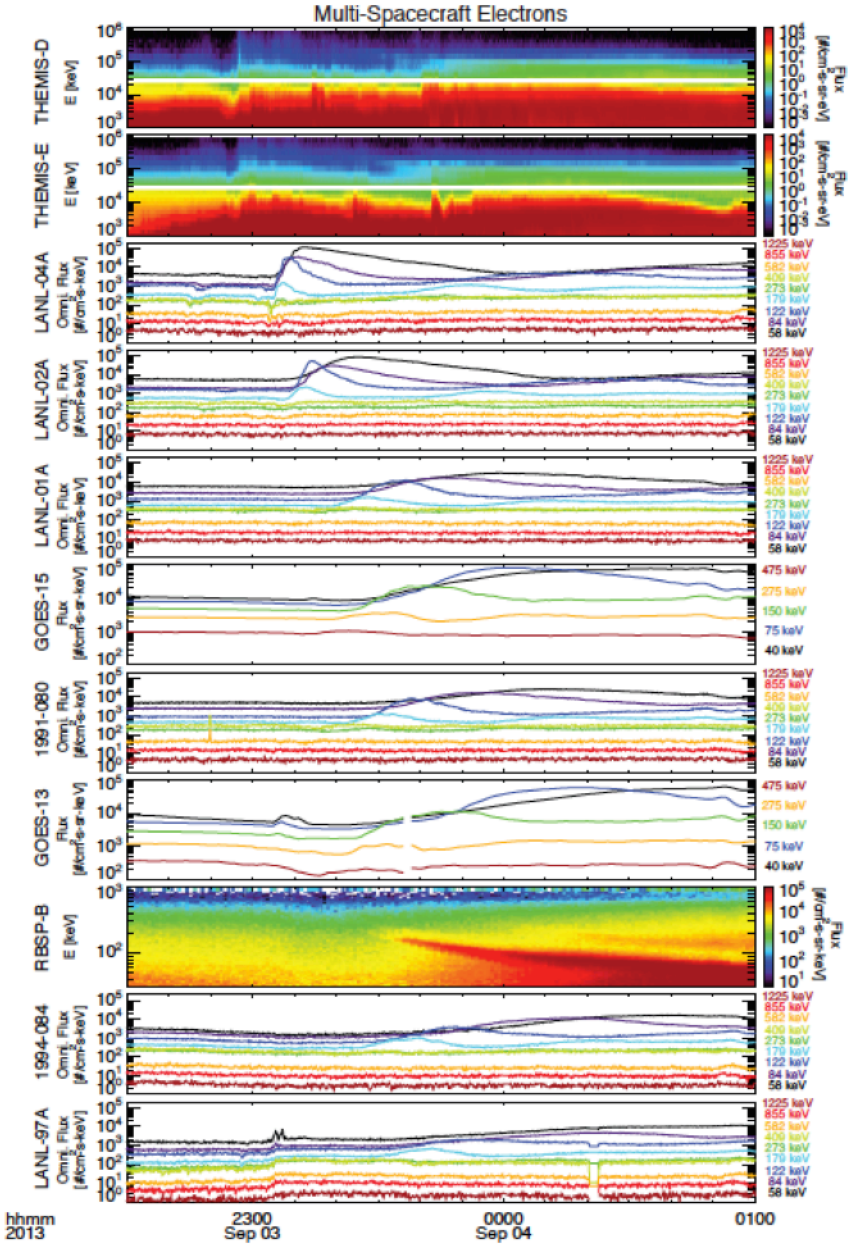

Figure 1: An example of multipoint observations of an isolated energetic particle injection from 03 Sep. 2013. Electron fluxes from 11 different spacecraft are shown in order of timing of the observed injection, with the first spacecraft to see the injection (THEMIS-D) at the top and the last (LANL-97A) at the bottom. All of these spacecraft also include ion data and many (THEMIS, GOES, and RBSP) can also measure fields and waves.

depths of such injections vary with solar wind and geomagnetic activity, and the subsequent effect these injections have on the outer belt electron population.

An example of multipoint observations of an isolated energetic electron injection is shown in Figure 1. Data from 11 different spacecraft are shown, and the spacecraft were located throughout the magnetosphere as shown in Figure 2. This event provides an excellent example of the unprecedented levels of coverage we now have throughout the system to address important outstanding questions concerning the importance of energetic particle injections for driving outer radiation belt variability. From Figure 1, the injection was first observed in the near-Earth plasma sheet by two of the three THEMIS probes (D and E). From magnetic field observations (not shown) and the timing of the energetic particle enhancements (seen at ~22:57 UT in Fig. 1), THEMIS clearly showed that the injection propagated Earthward and was associated with dipolarization of the magnetic field and strong Earthward plasma velocity and associated electric fields. From the spacecraft located over the full range of magnetic local times in the inner magnetosphere, it was clear that the electrons were injected down to at least L = 5.6 (where L is the radial distance in Earth radii to a magnetic field line's crossing point in the equatorial plane), where the injection was observed by RBSP-B. Furthermore, from the geosynchronous spacecraft (LANL and GOES constellations), we can clearly observe how the electrons undergo energy-dependent, eastward drift around the system on closed (i.e., trapped) trajectories. From the geosynchronous and RBSP-B probes, "drift echoes" of energetic particles are also observed; these are the subsequent enhancements of electrons at different energies after the initial injection as the particles drift around the system over time. With these spacecraft, we can also measure: the energetic ions associated with this injection; how different plasma wave modes (such as whistler-mode chorus [e.g., Santolik et al., 2004], hiss [e.g., Bortnik et al., 2008], and EMIC waves [e.g., Miyoshi et al., 2008]) are modulated by the injected particles; and the evolution of the outer belt electron distributions before, during, and after the injection event. Additional observatories can also be included, such as the low-Earth orbiting (LEO) POES/MetOp [e.g., Clilverd et al., 2010] and CSSWE [e.g., Li et al., 2013] spacecraft, BARREL balloons [e.g., Millan et al., 2011], and ground-based riometers [e.g., Spanswick et al., 2009], all of which can be used to measure electron losses from the radiation belt associated with the event.

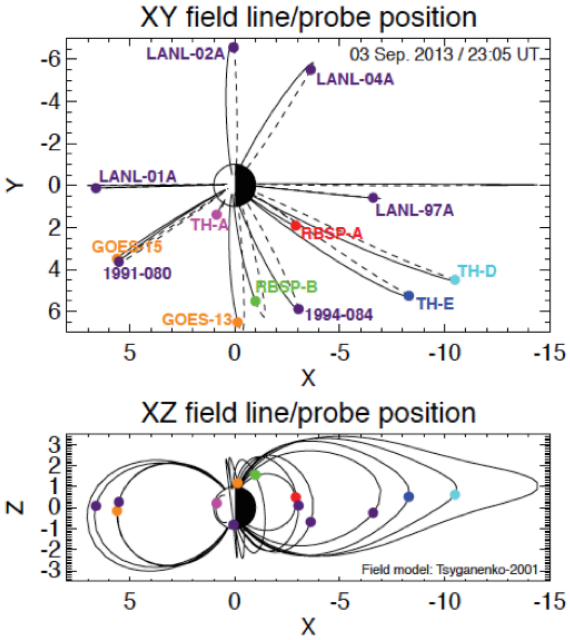

Figure 2: Spacecraft locations and magnetic field lines within Earth's magnetosphere for the 03 Sep. 2013 event from Fig. 1.

1.3 Strategy

For our proposed ISSI team project, we will use a data set of events like the example shown in Figure 1 to systematically investigate how energetic particle injections affect Earth's outer radiation belt electrons. The time period we will investigate will start from the beginning of full Van Allen Probes science observations in September 2012 and will last through the present time, and will be continually updated throughout the course of the proposed study. ***In particular, we will use this data set to collect statistics and address science questions on: the azimuthal location and width of injection sites; the penetration depth (in L-shell) of injections; the upper energy thresholds of injected particles (ions and electrons) as a function of L-shell; waves associated with distributions of injected particles; precipitation from conjunctions with LEO spacecraft, BARREL, and GBOs; evidence of acceleration of outer belt electrons associated with injections based on distributions observed by Van Allen Probes; and diffusion rates from drift echoes.*** We will incorporate data from: i) THEMIS and Cluster, which are capable of observing the source of these injections in the near-Earth plasma sheet; ii) geosynchronous spacecraft (i.e., LANL, GOES) that observe the injected particles as they are entering the outer belt zone; and iii) Van Allen Probes, which observes the effects they have on the outer belt; iv) low-altitude (POES/MetOp, CSSWE, BARREL) and ground-based observatories that provide observations required to understand losses from the system. We reiterate that the assembled team consists of experts in each of these data sets and topic (see Table 1, section 4, and the list of references). This combination of data sets provides us with an unparalleled constellation and observations required to test the abovementioned concepts and outstanding questions.

The proposed team will meet twice in Bern to allow for concentrated and focused investigation into this important topic in energetic particle physics. The first meeting will be used to: i) develop the set of standard criteria to systematically identify energetic particle injection events and establish the event list; ii) identify *at least* one ideal case study event to analyze at the meeting; and iii) outline the case study results in preparation of an initial publication on the topic. In the interim between meetings, we will establish the event list and data set in preparation for the work at the second meeting. The second meeting will focus on a broader understanding using statistics from the event list identified during the first meeting and interim period. At the second meeting, we will: i) review the preliminary findings from the statistical study that were produced during the interim period; ii) establish the methodology for the complete statistical study; and iii) outline expected publications of the results, including a review paper on topic based on the findings from the full ISSI team project.

Members will be required to arrive at the meetings prepared with their respective initial results (days 1-2), and the team will then spend the remainder of the week reviewing these results in person and combining them to develop a more complete picture of the underlying physics (days 2-4) and outlining our strategy for future work on the subject and publications and dissemination of the results (days 4-5). The benefits of working with data and a team of data experts on this study also means that highly efficient work can be done "on the spot" during the meetings themselves, with representatives from different missions literally analyzing, reviewing, and presenting additional and complementary results from their datasets in real time. Such a real-time analysis capability should produce a positive feedback response in terms of productivity, which will surely bolster the scientific results.

1.4 Timeliness

With the recent launch of Van Allen Probes adding two key points to the pre-existing array of outer belt observatories, the time is opportune for such a multipoint study as we are proposing, and this ISSI opportunity provides an ideal format to bring together such a team of experts to deliver focused research on these major outstanding questions in radiation belt physics. The proposed research promises to address several unanswered questions concerning source, acceleration, and loss processes for Earth's outer radiation belt electrons. Additionally, the results from this study will help scientists target new areas of research that can be addressed with future studies and the upcoming Japanese ERG mission, as well as strategies for conjugate observations between ERG and existing observatories. The proposed research also has broader impacts, since understanding the nature of acceleration and loss of energetic particles in Earth's magnetosphere sheds light on energetic particle processes in other plasma regimes throughout the Universe.

2. Goals and Expectations

We expect that this ISSI team, if supported, will be able to significantly advance our understanding of energetic particle injections and Earth's outer radiation belt. Our minimum success criterion is that the team's research efforts result in at least two peer-reviewed publications, one from each the case study from Meeting 1 and the statistical results from Meeting 2, and a full review paper on the topic. However, with such a team of experts assembled and analysing data from a number of candidate events of interest and complex and detailed statistical results, we are expecting that several more papers will be produced as a result of this focussed research effort. Additionally, we will disseminate results from these studies at international conferences such as the AGU Fall Meeting, EGU General Assembly, AOGS Meeting, and others. ISSI's support will be acknowledged on publications and presentations based on this research.

3. Relevance to ISSI

We are proposing to assemble an interdisciplinary group of scientists from various institutes in 10 different countries to perform data analysis with observations from an unprecedented amount of spacecraft and terrestrial observatories. Our focussed research will address several major outstanding questions concerning the nature of energetic particle injections and their importance to Earth's outer radiation belt electrons. Thus, this proposal is directly relevant to ISSI, whose mission defines it as "an Institute of Advanced Study where scientists from all over the world meet in a multi- and interdisciplinary setting to… contribute to the achievement of a deeper understanding of the results from different space missions [and] ground based observations… through multidisciplinary research in the framework of International Teams." This proposal falls under the ISSI research field of Space Sciences, since it addresses questions concerning Earth's radiation belts, which are part of Solar-Terrestrial Sciences and Space Plasma and Magnetospheric Physics. ISSI provides the proposed team with the added benefit to meet in person and devote two, focused weeks worth of effort entirely on this important topic. With researchers from 10 different countries, spanning 3

continents, ISSI is a unique opportunity and Bern an ideal forum to enable this team to conduct the proposed research.

4. Team Roster

Dr. Drew L. Turner (**Co-lead**); UCLA, USA	**Dr. Geoff D. Reeves** (**Co-lead**); LANL, USA	**Dr. Jacob Bortnik** UCLA/NJIT, USA	**Dr. Iannis Dandouras** IRAP, France
Prof. Eric Donovan U. Calgary, Canada	**Dr. Junga Hwang** KASI, Korea	**Dr. Elena Kronberg** Max Planck Inst., Germany	**Prof. Xinlin Li** LASP-CU, USA
Prof. Robyn Millan Dartmouth College, USA	**Dr. Yoshi Miyoshi** Nagoya U., Japan	**Dr. Ondrej Santolik** IAP, Czech Republic	**Dr. Aleksandr Ukhorskiy** JHU-APL, USA
External Advisors:			
Dr. Matt Taylor ESA, The Netherlands	**Dr. Mark Clilverd** BAS, United Kingdom	**Prof. Wenlong Liu** Beihang U., China	

Table 2: Proposed core team and external advisors. Each member's institute, and country of work are also listed. After the Lead and Co-Lead, the order is alphabetical by last name.

5. Schedule

We propose to conduct our first meeting in October 2014. The second meeting will be scheduled during the summer of 2015 (June - July). With this schedule, there is sufficient time between the two meetings to establish the event list, assemble the required data, and produce preliminary statistical results. With this timeline, we also have the benefits of the full array of Van Allen Probes orbit configurations and local time coverage, both BARREL campaigns to choose from for case study event selection and inclusion in the statistics, and on going coverage from the other missions identified in Table 1.

6. Budget and Facilities Requested

Budget: We request financial support for the following expenses for each of 2 1-week meetings in Bern, Switzerland:

- Living expenses in Bern for the 12 members of the core team (i.e., excluding external advisors; see Table 2)
- Travel expenses for the team co-leaders (D. L. Turner and G. D. Reeves) to/from Bern for one meeting each.
- If selected, we will also use the additional 20% of the budget offered by ISSI for young researcher participation
- Note: The external advisors (as listed in Table 2) will all participate at their own expense

Facilities: For both meetings, we will require a meeting room with projection capabilities and seating space for up to 20 people. The seating arrangement should allow those people to work comfortably on laptop computers. We also will require Internet connection and a sufficient number of power outlets in the meeting room. Though not required, we would greatly appreciate access to spare electrical adaptors, a white board and markers, and a coffee machine and hot water for tea.

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Drew L. Turner

Curriculum Vitae

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EDUCATION:

University of Colorado at Boulder (CU):

Ph.D. in Aerospace Engineering Sciences; Thesis Advisor: Prof. Xinlin Li; December 2010
M.S. in Aerospace Engineering Sciences; May 2008

Embry-Riddle Aeronautical University (ERAU), Daytona Beach, FL:

B.S. in Engineering Physics; Minor in Mathematics; December 2005

EXPERIENCE AND RESEARCH INTERESTS:

- Assistant Researcher: Data analysis of outer radiation belt electrons and foreshock phenomena at Earth, UCLA, Jan. 2010 - Present
- Systems Engineer and project management: Lomonosov instruments and ELFIN CubeSat projects, UCLA, Jan. 2010 – Present
- Graduate Research Assistant: Relativistic electron dynamics in Earth's outer radiation belt, Laboratory for Atmospheric and Space Physics, CU, Aug. 2006 - Dec. 2010
- REPTile Instrument Lead: Relativistic proton and electron instrument for CSSWE, an NSF funded CubeSat mission operating on orbit since September 2012, CU, Jan. 2008 - Dec. 2010
- Engineering Intern: System modeling for s/c attitude determination and control, Ball Aerospace and Technologies Corp., Boulder, CO, Summer 2005
- Research Intern: Data analysis of ionospheric total electron content derived from GPS, Arecibo Observatory, Puerto Rico, Summer 2004
- Data Analyst: Ionospheric total electron content and mesospheric air glow, Space Physics Research Laboratory, ERAU, Mar. 2002 - Mar. 2006

SELECT PUBLICATIONS OF RELEVANCE:

1. Turner, D. L., et al. (2014a), On the cause and extent of outer radiation belt losses during the 30 September 2012 dropout event, *Journal of Geophysical Research, 119*, doi:10.1002/2013JA019446.
2. Turner, D. L., et al. (2014b), Evidence of competing wave-particle interactions in Earth's outer radiation belt during the 30 Sep. – 02 Oct. 2012 geomagnetic storm, *Journal of Geophysical Research*, *119*, doi:10.1002/2014JA019770.
3. Turner, D. L., et al. (2013), On the storm-time evolution of relativistic electron phase space density in Earth's outer radiation belt, *Journal of Geophysical Research*, *118*, doi:10.1002/jgra.50151.
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Geoffrey D. Reeves

Education

University of Colorado, Boulder 1983	Physics	BA (*summa cum laude*)
Stanford University 1988	Applied Physics	Ph.D

Appointments

2005-present: Senior Scientist, Space Science & Applications Group, LANL.
1999-2005: Group Leader for Space Science & Applications, Los Alamos National Laboratory.
1991-1999: Staff scientist at Los Alamos National Laboratory.
April-October, 1997: Sabbatical - Max Planck Institut für Aeronomie, Germany
1989-1991: Post-doctoral research associate at Los Alamos National Laboratory.
1983-1988: Graduate Research Assistant at Stanford University. Thesis advisor, Peter M. Banks.
1981-1983: Undergraduate Research, University of Colorado.

Research & Activities in Space Plasma Physics:

Deputy PI/Science Team lead for the RBSP Energetic-particle Composition and Thermal-plasma (ECT) suite which comprises the HOPE, MagEIS, and REPT instruments and the ECT Science Operations Center.
Co-Investigator on: MMS, LANL/GEO, POLAR/CEPPAD, POLAR/CAMMICE, & CLUSTER/RAPID satellite investigations.
Leader of the Dynamic Radiation Environment Assimilation Model (DREAM) project which provides real-time and retrospective models of the natural and nuclear radiation belt environments.
Active in Space Weather activities including Space Environment Effects Working Group (SEEWG), NSF Space Weather Program, NASA Living With A Star (LWS) program, commercial and military anomaly investigations
Analyzed and published data from a variety of satellites programs: IMAGE, WIND, POLAR, GALILEO, GEOTAIL, DMSP, HEO, GPS, SAMPEX, GOES, CRRES, IMP-8, Viking, Freja, and LANL geosynchronous satellites and comparison of satellite data with ground-based observations including magnetometers and radars.
Research topics of interest include: radiation belt structure and dynamics, relativistic electron events, geomagnetic storms & substorms, energetic neutral atom imaging, solar proton events, effects of space environment on spacecraft and operations, magnetic field models and mapping, and energetic particle boundaries in the magnetosphere.
Recent Studies include:

1) Deriving physical understanding of radiation belt structure and dynamics using data assimilative models. Development of new 3D electron diffusion codes
2) Statistical analysis of the relationship between solar wind velocity and relativistic electron fluxes over two solar cycles (1989-2010)
3) Validation and prediction efficiency studies for the DREAM model
4) Development of a new model of the beta-decay electron belt produced by high altitude nuclear explosions
5) Statistical analysis of geosynchronous satellite anomalies
6) Studies of relativistic electron dropout (loss) events throughout the outer electron belt

Publications: (available by request or at **http://www.researcherid.com/rid/E-8101-2011**)
41 first-author publications + 252 co-author publications: 184 with data in the web of science
h-index = 42

Awards: *Los Alamos National Laboratory Fellow's Prize for Outstanding Scientific Leadership (2012)*

Biographical sketch of Jacob Bortnik

Education

Ph.D., Electrical Engineering Department., Stanford University, 2004; Advisor: Prof. Umran S. Inan; Thesis title: "Precipitation of radiation-belt electrons by lightning-generated, magnetospherically reflected whistler waves".

B.Sc. (1996), and M.Sc. (1998) Electrical Engineering Department., University of the Witwatersrand (WITS), Johannesburg, South Africa.

Experience

July 2012-present: Researcher, Dept. of Atmos. & Oceanic Sciences, UCLA
Aug 2011-present: Visiting scholar, Center for Solar-Terrestrial Research, NJIT
July 2010-June 2012: Associate Researcher, Dept. of Atmos. & Oceanic Sciences, UCLA
Oct. 2006-June 2010: Assistant Researcher, Dept. of Atmos. & Oceanic Sciences, UCLA
Nov 2008- present: Solana Scientific Inc. Consultant, San Diego, CA.
Sept 2004-Sept. 2006: Postdoctoral Scholar, Dept. of Atmos. & Ocean. Sciences, UCLA
July 2004-present: QuakeFinder Consultant, Palo Alto, CA.
July-Sept 2004: Postdoctoral Scholar, EE Dept, Stanford University
1998-2004: Research Assistant, EE Dept, Stanford University
1997-1998: Professional assistant, EE dept, High Voltage group, WITS

Research activities and interests

Dr. Bortnik has been actively involved in modeling the propagation of various whistler mode waves in the near-Earth space environment, and the linear, nonlinear, and non-resonant wave-particle interaction between waves and the energetic electrons that comprise the Earth's radiation belts. He has performed statistical analysis of a variety of wave and particle data sets. In 2008, Dr. Bortnik demonstrated for the first time the connection between ELF/VLF chorus and plasmaspheric hiss, which was published in the journal *Nature*, and listed as one of the top 100 stories of 2008 in *Discover* magazine. In 2009, he reported on the first observation of this correlation in the journal *Science*. In addition, Dr. Bortnik is interested in modeling of the excitation and propagation of a variety of plasma waves in the Earth's magnetosphere, as well as methods of automatic identification and statistical data analysis.

Relevant Publications

1. Chen, L., W. Li, J. Bortnik, and R. M. Thorne, Amplification of whistler-mode hiss inside the plasmasphere, *Geophys. Res. Lett.*, Vol. 39, Iss. 8, CiteID L08111, 2012
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Education :

- 1988 : *Doctorat d'Etat* (Ph.D.), Paul Sabatier University, Toulouse.
- 1983 : *Doctorat de Troisième Cycle*, Paul Sabatier University, Toulouse.
- 1981 : D.E.A. (*Diplôme d'Etudes Approfondies*) in Space Physics, Paul Sabatier University.
- 1980 : B.Sc. degree in Physics, University of Athens, Greece.

Appointments :

- since Oct. 2009 : *Directeur de Recherche* at CNRS (*Centre National de la Recherche Scientifique*), at the CESR laboratory, which since January 2011 is the IRAP laboratory, Toulouse.
- Oct. 1989 - Sep. 2009 : *Chargé de Recherche* at CNRS, at the CESR laboratory.
- 1989 : Visiting scientist at the Space Sciences Laboratory, University of California, Berkeley, and at the Geophysics Program, University of Washington, Seattle.
- 1984 - 1988 : Graduate Research Associate, CNES (*Centre National d'Etudes Spatiales*).

Research Interests :

Research interests include solar wind-magnetosphere coupling, terrestrial magnetosphere dynamics, and in particular the dynamics of the inner magnetosphere (plasmasphere, ring current, radiation belts, exosphere and their interactions). Research interests include also the dynamics of the magnetospheres of the outer planets, and in particular Saturn's magnetosphere and its interaction with Titan.

Experience in Space Science Missions :

- PI in the ESA Cluster 4-spacecraft mission (CIS-Cluster Ion Spectrometry experiment).
- Deputy PI in the CNSA / ESA Double Star 2-spacecraft mission (HIA experiment).
- Lead Co-I at IRAP for the MIMI experiment (Magnetospheric Imaging Instr.) onboard the Cassini Saturn orbiter.
- Lead Co-I at IRAP for the SERENA experiment (Search for Exospheric Refilling and Emitted Neutral Abundances) onboard the BepiColombo mission, in preparation for Mercury (MPO).
- Co-I of the IMPACT experiment onboard the STEREO mission.

Professional Committee Assignments:

- President of the ST (Solar-Terrestrial Sciences) Division of EGU, 2008-2011.
- Vice-President of the PS (Planetary and Solar System Sciences) Division of EGU, since 2011.
- MAARBLE (Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization) project External Advisory Committee member.
- CNES Sun-Heliosphere-Magnetosphere Advisory Group, 2006-2011.
- French Committee for SCOSTEP (Scientific Committee of Solar Terrestrial Physics).
- Member of several working groups (ESA CSDS IWG, ESA Cluster SOWG, CNSA / ESA DSDS, ISSI, …)
- Past member of the CDPP (*Centre de Données de la Physique des Plasmas*) Implementation Working Group, of the French Space Weather Working Group (PNST), and of the Scientific and Technical Council of CESR.
- Research proposals evaluations for NASA, ANR (*Agence Nat. de la Rech.*), SNSB (Swedish Nat. Space B.), …
- Supervisor of 10 PhD students; member of several PhD thesis committees.

Selected publications in refereed journals (from a list of more than 250):

Dandouras, Detection of a plasmaspheric wind in the Earth's magnetosphere by the Cluster spacecraft, *Ann. Geophys.,* 31, 1143-1153, doi:10.5194/angeo-31-1143-2013, 2013.

Dandouras et al., Energetic ion dynamics of the inner magnetosphere revealed in coordinated Cluster- Double Star observations*, J. Geophys. Res.*, 114, doi:10.1029/2007JA012757, 2009.

Dandouras et al., Magnetosphere response to the 2005 and 2006 extreme solar events as observed by the Cluster and Double Star spacecraft*, Adv. Space Res.*, 43, 618-623, doi:10.1016/j.asr.2008.10.015, 2009.

Dandouras et al., Titan's exosphere and its interaction with Saturn's magnetosphere*, Philosophical Transactions of the Royal Society - A*, doi:10.1098/rsta.2008.0249, 2008.

Dandouras and Amsif, Production and Imaging of Energetic Neutral Atoms from Titan's Exosphere: a 3-D Model, *Planet. Space Sci.*, 47, 1355, 1999.

Eric Donovan – Abridged Curriculum Vitae

Employment History

Full Professor	U. Calgary	2011-present
Canada Research Chair (TII)	U. Calgary	2004-present
Associate Professor	U. Calgary	2002-2011
Assistant Professor	U. Calgary	1997-2002
PDF	U. Alberta; IRF Uppsala; U. Calgary	1993-1997

Degrees

Ph.D. (Physics)	U. Alberta	1993
M.Sc. (Physics)	U. Western Ontario	1988
B.Sc. (Physics)	U. Western Ontario	1986

Research Program and Other Evidence of Impact

The overall theme of Dr. Donovan's research is **geospace energy and mass transport**, with focus on using optical, radar, and riometer data to remote sense magnetospheric dynamics.

Dr. Donovan is the PI of the CSA funded Canadian GeoSpace Monitoring (CGSM) All-Sky Imager and Riometer arrays. His group deployed, operates, and recovers the data from the 16 white light ASIs located in Canada as part of NASA's THEMIS mission, and founded the international GAIA Virtual Observatory program. He conceived of a two-satellite auroral imaging mission (Ravens), a concept developed by Dr. Donovan's team through a Phase A study for 24/7 UV Auroral Imaging on the proposed Canadian PCW satellite mission. He is PI of the Canadian face of the Resolute Bay Incoherent Scatter Radar (RISR), expected online July 2013.

Dr. Donovan is Chair-Elect (2011-2013) and will be Chair (2013-2015) of the NSF GEM Science Steering Committee. He is on ESA's SWARM Mission Advisory Group, and has served on the CEDAR Science Steering Committee, and the EISCAT Science Advisory Committee. He is CoI on NASA's RBSM (for EFW) and THEMIS missions. Together with John Samson and Igor Voronkov, he wrote the science plan for the CANOPUS project in the years 2000 and beyond. He led the Canadian community proposal to the CSA for CGSM, the program that evolved from CANOPUS, and that is now one of the highest funded ongoing CSA science programs.

Dr. Donovan has been the author or co-author of over 170 refereed, and 20 non-refereed publications, and has given over 60 invited talks, colloquia, and seminars.

Representative Publications (underline indicates member of Donovan's group)

Donovan, E., E. Spanswick, J. Liang, J. Grant, B. Jackel, and M. Greffen, Magnetospheric dynamics and the proton aurora, *Auroral Phenomenology and Magnetospheric Processes: Earth and Other Planets, AGU Monograph*, Ed. by Keiling, Donovan, Bagenal, and Karlsson, 2012.

Liang, J., E. Spanswick, M. Nicolls, **E. Donovan**, D. Lummerzheim, and W. Liu, Multi-instrument observations of soft e- precipitation and its association with magnetospheric flows, *JGR.*, 2011.

Spanswick, E., G. Reeves, **E. Donovan**, and R. Friedel, Injection region propagation outside of geosynchronous orbit, *JGR*, 2010.

Donovan, **E**., et al. (including E. Spanswick, G., B. Jackel, T. Trondsen, and M Syrjäsuo), Simultaneous *in situ* and ground-based observations of a small substorm, *GRL,* 2008.

Spanswick, E., **E. Donovan**, R. Friedel, and A. Korth, Ground based identification of dispersionless electron injections, *Geophys. Res. Lett*., *34*, 2007.

Representative Invited Talks

The Substorm, *Invited Lecture,* Heliophysics Summer School, Boulder, June, 2012.

Magnetospheric Drivers of the Aurora, *Tutorial*, 38th Annual Meeting for Studies of the Upper Atmosphere by Optical Methods, Helsinki, August, 2011.

Imaging the Aurora, Plenary *Interdisciplinary Lecture*, COSPAR, Montreal, July, 2008.

Junga Hwang

CONTACT:
Korea Astronomy and Space Science Institute,
776, Daedeok-daero, Yuseong gu, Daejeon, 305-348 SOUTH KOREA
Phone: (82) 42-865-2061 / E-mail: jahwang@kasi.re.kr, junga.hwang@gmail.com

EDUCATION:
- Ph.D : Korea Advanced Institute of Science and Technology (KAIST), 2006, Department of Physics, Thesis: "Dynamics of Relativistic Electrons: Seed Electrons and Wave-particle Interactions in the outer magnetosphere"
- M.S. : KAIST, Department of Physics, 2001
- B.A. : KAIST, Department of Physics, 1999

APPOINTMENTS:
- Satellite Research Center (SatReC) (2000-2003, Researcher)
- Physical Science Research Center (2006, Post-Doc)
- Korea Astronomy and Space Science (KASI) (2006-2007, Post-Doc)
- Korea Astronomy and Space Science (KASI) (2007-current, Senior Researcher)

EXPERIENCE&RESEARCH INTERESTS:
- Developing Space Physics Payloads for STSAT-1
- Seed particles and Wave-particle interactions in the radiation belt
- Solar Energetic Particles and Corona Mass Ejection

SELECTED PUBLICATIONS OF RELEVANCE:
1. J. Hwang, D.-Y. Lee, K.-C. Kim, D.-K. Shin, J.-H. Kim, J.-H. Cho, M.-Y. Park, and D. L. Turner, Significant loss of energetic electrons at the heart of the outer radiation belt during weak magnetic storms, J. Geophys. Res., 118, 4221-4236, 2013
2. Junga Hwang, Khan-Hyuk Kim, Kyoung-Suk Cho and Young-Deuk Park, Analysis of the Correlations between the Occurrence of Substorm Injections and Interplanetary Parameters during the Declining Phase of Solar Cycle 23, Journal of the Korean Physical Society, 53(2), 897-903, 2008
3. Hwang, J., D. Lee, L. Lyons, A. Smith, S. Zou, K. D. Min, K. Kim, Y. Moon, and Y. Park, Statistical significance of association between whistler-mode chorus enhancements and enhanced convection periods during high-speed streams, J. Geophys. Res., 112(A9), A09213, 2007
4. Junga Hwang, Kyoung Wook Min, Ensang Lee, China Lee, and Dae Young Lee, A case study to determine the relationship of relativistic electron events to substorm injections and ULF power, Geophysical Research Letters, 31, L23801, 2004

AWARDS: "*Mentor of the Year*", 2013, Ministry of Science, ICT, and Future Planning

Elena A. Kronberg

Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, Göttingen, 37077, Germany

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Research Interests

Dynamics of the terrestrial magnetosphere, the ion composition in the Earth's magnetosphere, the region upstream to the Earth's bow shock, energetic particle observations in the Jovian magnetosphere

Employment

Max-Planck Institute for Solar System Research	Staff scientist	since November 2006
Max-Planck Institute for Solar System Research	Postdoc	May - October 2006
Altai State University	Teaching assistant	September 2001- December 2002

Education

Technical University of Braunschweig/ Max-Planck Institute for Solar System Research	PhD: "Dynamics of the Jovian magnetotail"	2003-2006
Altai State University	Master in physics with Honor	2001

Space Missions Involvement

- The Cluster/RAPID Co-Investigator
- Cluster Active Archive assistant, RAPID data calibration (also in radiation belts) and processing
- Galileo data analysis

Publications

33 peer reviewed publications

Selected peer reviewed publications

Oxygen and hydrogen abundance in the near-Earth magnetosphere: Statistical results on the response to the geomagnetic and solar wind activity conditions, **Kronberg E. A.**, S. E. Haaland, P. W. Daly, E. Grigorenko, L. M. Kistler, M. Fränz, and I. Dandouras, J. Geophys. Res., 117, A12208, 10.1029/2011JA018071, 2012

On the origin of the energetic ion events measured upstream of the Earth's bow shock by STEREO, Cluster, and Geotail, **Kronberg, E. A.**, R. Bučík, S. Haaland, B. Klecker, K. Keika, M. Desai, P. W. Daly, M. Yamauchi, R. Gómez-Herrero, and A. T. Y. Lui, J. Geophys. Res., 116, A02210, doi:10.1029/2010JA015561, 2011.

Spectral characteristics of protons in the Earth's plasmasheet: statistical results from Cluster CIS and RAPID, Haaland, S., **E. A**. **Kronberg,** P. W. Daly, M. Fränz, L. Degener, E. Gerogescu and I. Dandouras, Ann. Geophys., 28, 1483-1498, doi:10.5194/angeo-28-1483-2010, 2010

Generation and validation of ion spectra based on Cluster RAPID and CIS measurements, **Kronberg E. A**., P. W. Daly, I. Dandouras, S. Haaland and E. Georgescu, The Cluster Active Archive Studying the Earth's Space Plasma Environments, *Astrophysics and Space Science Proceedings,* doi:10.1007/978-90-481-3499-1_20, 2010

RAPID Products at the Cluster Active Archive, Daly P. W. and **Kronberg E. A,** The Cluster Active Archive Studying the Earth's Space Plasma Environments, *Astrophysics and Space Science Proceedings,* doi:10.1007/978-90-481-3499-1_9, 2010

Xinlin Li, Professor
Dept. of Aerospace Engineering Sciences and Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado; 303-492-3514; lix@lasp.colorado.edu

Education:

1986-1992	Dartmouth College, New Hampshire, Ph.D. in Physics.
1982-1985	Shanghai Institute of Optics and Fine Mechanics, Academia Sinica, M.S. in Physics.
1978-1982	University of Science and Technology of China, B.S. in Physics

Employment:

2011-Present, Dept. of Aerospace Engineering Science (AES) and Laboratory for Atmospheric and Space Physics (LASP), University of Colorado (CU) at Boulder, Professor
2002-2009, Dept. of AES and LASP, CU/Boulder, Associate Professor
1999-2002, Dept. AES and LASP, CU/Boulder, Associate Research Professor
1995-1999, LASP, CU/Boulder, Research Associate
1993-1995, Dartmouth College, Research Associate
1992-1993, Dartmouth College, Postdoctoral Research Associate
1989-1991, Dartmouth College, Research Assistant
1987-Summer, Space Sciences Laboratory at UC Berkeley, visiting graduate student
1986-1989, Dartmouth College, Teaching Assistant
1985-1986, Shanghai University of Science and Technology, Lecturer

Experiences and Responsibilities:

Principal research interests are studies of solar wind energy coupling into Earth's magnetosphere and of energetic particle dynamics in the magnetosphere. Current research includes analysis and interpretation of particle and field data from satellites and ground stations, energetic particle instrument development, modeling and simulation of energetic particle transport associated with magnetic storms and substorms, and real-time forecast of MeV electrons and the Dst and AL index. Teaching activities include aerospace environment, space dynamics, thermodynamics, and space-flight hardware design. Recently, he was awarded a CubeSat project from NSF and has been leading a group of graduate students as they design, build, calibrate, and test the CubeSat system, which was delivered in Jan of 2012 and launched on 13 September 2012 to measure energetic particles in space.

Principal Investigator (PI) on NSF funded CubeSat mission: Colorado Student Space Weather Experiment (CSSWE), launched on 13 September 2012.

Co-Investigator of NASA/IMEX (Inner Magnetosphere Explorer), a university explorer project, we completed the Phase A study, 1998-1999. PI: John Wygant.

Co-Investigator of NASA/SAMPEX (Solar, Anomalous, and Magnetospheric Particle Explorer). Data are still collected and data analysis and archiving continues. PI: Glenn Mason.

Co-Investigator on NASA/LWS/RBSP/Electric Field and Waves (EFW), launched on 30 August 2012. PI: John Wygant.

Co-Investigator on NASA/LWS/RBSP/Energetic Particle, Composition, and Thermal Plasma (ECT) instrument suite, to be launched on 30 August 2012. PI: Harlan Spence.

Co-Investigator on NASA/THEMIS (Time History of Events and Macroscale Interactions During Substorms) mission. PI: Vassilis Angelopoulos. Currently we are on extended mission.

Deputy-PI on NASA/LWS/RBSP/Mission of Opportunity Radbelt Experiment (MORE), we completed the phase A study, 2007-2009. PI: Dan Baker.

Publications: authored and co-authored over 100 peer-reviewed journal publications.

ROBYN M. MILLAN

EDUCATION:	2002	Ph.D., Physics, University of California, Berkeley
	1999	M.A., Physics, University of California, Berkeley
	1995	B.A., Astronomy, Physics, University of California, Berkeley
APPOINTMENTS:	2011 - Present	Associate Professor, Dartmouth College
	2005-2011	Assistant Professor, Dartmouth College
	2002-2005	Research Assistant Professor, Dartmouth College
	Summer 2002	Postdoctoral Research Assistant, U. C. Berkeley
AWARDS:	2011	Dartmouth Dean of the Faculty Award for Outstanding Mentoring and Advising
	2008	2008 Editor's Citation for Excellence in Refereeing for JGR Space Physics
	2002	NH Space Grant Visiting Young Scholar Award, Dartmouth College
	1998-2001	NASA Graduate Student Research Program Fellowship
	1995	Dorthea Klumpke Roberts Award, University of California, Berkeley
	1995	Department Citation, Astronomy, University of California, Berkeley

SELECTED REFEREED PUBLICATIONS:

Millan, R. M. and the BARREL Team, " The Balloon Array for RBSP Relativistic Electron Losses (BARREL)", *Space Science Reviews*, doi:10.1007/s11214-013-9971-z, 2013.

Blum, L. W., Q. Schiller, X. Li, **R. Millan**, A. Halford, and L. Woodger, "New conjunctive CubeSat and balloon measurements to quantify rapid energetic electron precipitation", *Geophys. Res. Lett.*, 40, 58335837, doi:10.1002/2013GL058546, 2013.

Li, Z., **R. M. Millan**, and M. K. Hudson, "Simulation of the energy distribution of relativistic electron precipitation caused by quasi-linear interactions with EMIC waves", *J. Geophys. Res. Space Physics*, 118, 75767583, doi:10.1002/2013JA019163, 2013.

Brito, T., L. Woodger, M. Hudson, and **R. Millan**, "Energetic radiation belt electron precipitation showing ULF modulation", *Geophys. Res. Lett.*, doi:10.1029/2012GL053790, 2012.

Millan, R. M. and D. N. Baker, "Acceleration of Particles to High Energies in Earth's Radiation Belts", *Space Science Reviews*, 173, 103-131, 2012.

Yando, K. B., **R. M. Millan**, J. C. Green, and D. S. Evans, "A Monte Carlo Simulation of the POES Medium Energy Proton and Electron Detector", *J. Geophys. Res.*, 116, A10231, doi:10.1029/2011JA016671, 2011.

Millan, R.M., "Understanding relativistic electron losses with BARREL", *Journal of Atmospheric and Solar- Terrestrial Physics*, doi:10.1016/j.jastp.2011.01.006, 2011.

Millan, R. M., K. B. Yando, J. C. Green, and A. Y. Ukhorskiy, "Spatial distribution of relativistic electron precipitation during a radiation belt depletion event", *Geophys. Res. Lett.*, 37, L20103, doi:10.1029/2010GL044919, 2010.

Millan, R. M, and R. M. Thorne, "Review of Radiation Belt Relativistic Electron Losses", *J. Atmos. Solar Terr. Physics*, **69**, 362-377, 2007.

Millan, R. M., R. P. Lin, M. P. McCarthy, "Observation of relativistic electron precipitation during a rapid decrease of trapped relativistic electron flux", *Geophys. Res. Lett.*,**34**, L10101, doi:10.1029/2006GL028653, 2007.

Yoshizumi Miyoshi

Yoshizumi Miyoshi is an associate professor of Nagoya University, and the project scientist of the ERG project. His research focuses on terrestrial and planetary radiation belts, aurora particle accelerations, and solar wind – terrestrial/planetary magnetosphere couplings. He is also interested in plasma wave particle interactions, and he studies the data analysis on various satellites and the simulation studies.

Education:

B.S. (1996), M.S.(1998), Ph.D.(2001), Tohoku University, Japan

Employment:

Associate Professor, Solar-Terrestrial Environment Laboratory, Nagoya University, Japan, 2012-present

Assistant Professor, Solar-Terrestrial Environment Laboratory, Nagoya University, Japan, 2004-2011

Visiting Researcher, University of New Hampshire, USA, 2002-2003

Research Fellow of Japan Society for the Promotion of Science, 2001-2003

Professional Activities:

Vice Chair of COSPAR/PRBEM, 2010-present

Associate Editor of Journal of Geophysical Research, AGU, 2012-present

Experiences for Space missions:

Project Scientist: Geosplace Exploration Project (ERG)

Co-Investigater: JUICE/RPWI. Van Allen Probes/RBSPICE, BepiColombo MMO/MPPE

Awards:

Obayashi Prize, Society of Geomagnetism and Earth, Planetary and Space Sciences, Japan, 2006

Morita Prize, Tohoku University, Japan, 2009

The Young Scientist's Prize, The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Japan, 2013

Publications:

130 refereed publications, Three Books (author, co-author and Editor)

Selected Papers:

Miyoshi, Y. et al., Rebuilding process of the outer radiation belt during the November 3, 1993, magnetic storm - NOAA and EXOS-D observations, J. Geophys. Res. , 108, 1004, doi:10.1029/2001JA007542, 2003.

Miyoshi, Y. et al., Precipitation of radiation belt electrons by EMIC waves, observed from ground and space, Geophys. Res. Lett., 35, L23101, doi:10.1029/2008GL035727, 2008.

Miyoshi, Y. et al., The Energization and Radiation in Geospace (ERG) Project, in Dynamics of the Earth's Radiation Belts and Inner Magnetosphere, pp.103-116, AGU, Washington, D.C. doi:10.1029/2012BK001304, 2012.

Miyoshi, Y. et al., High-speed solar wind with southward interplanetary magnetic field causes relativistic electron flux enhancement of the outer radiation belt via enhanced condition of whistler waves, Geophys. Res. Lett., 40, doi:10.1002/grl.50916, 2013.

Ondřej Santolík - Curriculum Vitae

Education:

1990 M.Sc., Physics, Charles University in Prague, Czech Republic.
1995 Ph.D., Physics, Charles University in Prague, Czech Republic
1995 Ph.D., Physics, Universite d'Orleans, Orleans, France.

Professional experience:

1995-1996	Charles University in Prague, Research Assistant
1996-2004	Charles University in Prague, Assistant Professor
1997-2004	Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic (ASCR), Research Scientist
1999-2000	Postdoctoral Research Scientist, LPCE/CNRS Orléans, France
2000-2001	Visiting Research Scientist, University of Iowa, USA (J. W. Fulbright scholarship)
2002-2012	during summer breaks: Visiting Research Scientist, University of Iowa, USA
2004-now	Charles University in Prague, Associate Professor
2004-now	Institute of Atmospheric Physics ASCR, Senior Research Scientist
2007	Visiting professor, Université d'Orléans, France
2007-2010	Deputy Director of the Institute of Atmospheric Physics ASCR
2010-now	Head of the Department of Space Physics, Institute of Atmospheric Physics ASCR.

Scientific Interests:

Dr. Santolik is active in physics of plasmas, and in spacecraft data analysis and interpretation with a focus on plasma waves and related processes. Recent research topics include both linear and nonlinear wave emissions in space plasmas of the magnetospheres of the Earth and Saturn, and their interaction with plasma medium and energetic particles.

Dr. Santolik has 20 years experience in spacecraft data analysis, interpretation, and in spacecraft scientific instrumentation. He is currently leading the team efforts of building a high-frequency analyzer as a Lead Co-Investigator of the IME/HF instrument in the Taranis spacecraft project, and electromagnetic analyzers ELMAVAN and LEMRA-L as a Principal Investigator in the Resonance and Luna-Glob spacecraft projects. He also is a Co-Investigator (Co-I) of the Waves experiment on the STEREO spacecraft, Co-I of STAFF and WBD instruments onboard the Cluster spacecraft, Co-I of the STAFF instrument on the Double-Star spacecraft, and Co-I of the EMFISIS instrument on the Van Allen Probes spacecraft. He also participated on data analysis of scientific instruments onboard the Intershock, APEX, Interball, Magion, Freja, Polar, DEMETER and Cassini spacecraft missions.

Dr. Santolik is an author or co-author of more than 170 scientific articles in international refereed journals, with 14.5 average citations per article and with an h-index of 28.

Other activities:

In 2008 he was elected Vice-Chair of Commission H (Wave in plasmas including laboratory plasmas), of the Union Radio-Scientifique Internationale (URSI). From 2011 he serves as a Chair of this Commission. Since 2010 he also serves as a Vice-Chair of the Panel on Capacity Building of the Committee on Space Research (COSPAR). Since 2010 Dr. Santolik works as a member of the scientific advisory structure of the European Space Agency. He serves as a reviewer of international scientific journals and grant agencies.

Aleksandr Y. Ukhorskiy

Senior Staff, The Johns Hopkins University Applied Physics Laboratory Laurel, Maryland, 20723

Education

M.S., physics, 1999, Moscow Institute of Physics and Technology

Ph.D., physics, 2003, University of Maryland College Park

Positions

Senior Staff, JHU/APL, 2006-present; Post-Doctoral Research Associate, JHU/APL, 2003-2006; Graduate Research Assistant, University of Maryland, 2000-2003

Relevant Experience

Test-particle simulations of the electron radiation belt; Theoretical analysis of radial transport and energization of the inner magnetospheric particles; Analysis and interpretation of ULF waves in the inner magnetosphere; Calculation of storm-time induced electric fields; Numerical simulations and theoretical analysis of MHD wave propagation in the inner magnetosphere and their impact on radiation belt particles; Empirical models of the electron radiation belt; Analysis and interpretation of wave-particle interaction and its impact of ring current ions;

A member of American Geophysical Union

Recent Related Publications

Ukhorskiy, A.Y., M. I. Sitnov, D. G. Mitchell, K. Takahashi, L. J. Lanzerotti, B. H. Mauk (2014), Rotationally driven "zebra stripes" in Earth's inner electron belt, Nature, doi: 10.1038/nature13046.

Ukhorskiy, A. Y., M. I. Sitnov, R. M. Millan, and B. T. Kress (2014), Enhanced radial transport and energization of radiation belt electrons due to drift orbit bifurcations, J. Geophys. Res., 119, doi: 10.1002/2013JA019315.

Ukhorskiy, A. Y., M. I. Sitnov, V. G. Merkin, and A. V. Artemyev (2013), Rapid acceleration of protons upstream of earthward propagating dipolarization fronts, J. Geophys. Res. Space Physics, 118, doi: 10.1002/jgra.50452.

Ukhorskiy, A. Y., and Sitnov, M. I. (2012), Dynamics of Radiation Belt Particles. Space Sci. Revi, doi: 10.1007/s11214-012-9938-5.

Ukhorskiy, A. Y., B. H. Mauk, N. J. Fox, D. G. Sibeck, J. M. and Grebowsky (2011), Radiation Belt Storm Probes: Resolving fundamental physics with practical consequences, JASTP, 73, 1417.

Ukhorskiy, A. Y., M. I. Sitnov, R. M. Millan, and B. T. Kress (2011), The role of drift orbit bifurcations in energization and loss of electrons in the outer radiation belt, J. Geophys. Res., 116, A09208, doi: 10.1029/2011JA016623.

Ukhorskiy, A. Y., M. I. Sitnov, K. Takahashi, and B. J. Anderson (2009), Radial transport of radiation belt electrons due to stormtime Pc5 waves, Ann. Geophys., 27(5), 2173.

Ukhorskiy, A. Y., M. I. Sitnov (2008), Radial transport in the outer radiation belt due to global magnetospheric compressions, JASTP, 70, 1714.

Ukhorskiy, A. Y., B. J. Anderson, P. C. Brandt, N. A. Tsyganenko (2006), Storm-time evolution of the outer radiation belt: Transport and losses, J. Geophys. Res., 111, A11S03, doi: 10.1029/2006JA011690.

Ukhorskiy, A. Y., B. J. Anderson, K. Takahashi, N. A. Tsyganenko (2006), The impact of ULF oscillations in solar wind dynamic pressure on the outer radiation belt electrons, Geophys. Res. Lett., 33, L06111, doi:10.1029/2005GL024380.

Ukhorskiy, A.Y., K. Takahashi, B. J. Anderson, H. Korth (2005), The impact of toroidal ULF waves on the outer radiation belt electrons, J.Geophys. Res., 110,A10202, doi:10.1029/2005JA011017, 2005.

Short Curriculum Vitae for Matthew G.G.T. Taylor

Address: ESA/ESTEC, RSSD SRE-OOC, Keperlaan 1, 2201 AZ, Noordwijk ZH, The Netherlands
Telephone: +31 71 565 8009
Fax: +31 71 565 4697
Email: mtaylor@rssd.esa.int

Current position:
Acting Project Scientist for Cluster and Double Star. Activity includes coordinating Cluster spacecraft and instrument operations in collaboration with other spacecraft, including THEMIS, Van Allen Probes (along with BARREL balloon campaign) and Swarm.
Co- Investigator on Cluster RAPID and PEACE and Double Star PEACE instruments.
Co-PI of previous ISSI working team, 'Comparative Cluster-Double Star measurements of the dayside magnetosphere'. PI. M.W. Dunlop
External member of current ISSI international team 'Dawn-Dusk Asymmetries in the Coupled Solar-Wind Magnetosphere –Ionosphere System', PI: A.Walsh.
Participant of the ISSI Forum "Near Earth Electro-magnetic Environment (Swarm and Cluster).

Recent Research activities include:

- Multipoint and multi instrument analysis of magnetospheric phenomena including case study investigations of substorms, flux transfer events and the cusp.
- Multipoint measurements of electron phase space density in the Earths magnetotail, to examine the dominant processes of acceleration and transport of relativistic electrons into the radiation belts.
- The persistence and structure of the mid-tail plasma sheet using magnetic field and high and thermal electron measurements.
- Formation and persistence of the cold, dense plasma sheet.
- Studying the formation and evolution of the magnetopause and associated boundary layers using multi-mission datasets.

Relevant publications:
Taylor, M.G.G.T, R.H.W. Friedel, G.D. Reeves, M.W.Dunlop, T.A.Fritz, P.W.Daly and A. Balogh**,** *'Multi-satellite measurements of electron phase space density gradients in the Earth's magnetotail*', Journal of Geophysical Research, vol. 109, no. A5, 10.1029/2003JA010294, May 2004
Vallat, C., N.Ganushkina, I. Dandouras, C.P. Escoubet, **M.G.G.T Taylor**, H. Laakso, A. Masson, J-A.Sauvaud, H.Reme, P. Daly, Ion multi-nose structures observed by Cluster in the inner magnetosphere, , *Ann. Geophys.*, Vol.25, pp. 171-190, SRef-ID: 1432-0576/angeo/2007-25-171, 2007
Åsnes, A., R. W. H. Friedel, B. Lavraud, G. D. Reeves, **M. G. G. T. Taylor**, and P. Daly (2008), Statistical properties of tail plasma sheet electrons above 40 keV, J. Geophys. Res., 113, A03202, doi:10.1029/2007JA012502.
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Scientific Interests	Experimental Upper Atmosphere and Space Physics focused on the coupling of energy inputs into the Earth-system and its atmospheric consequences. Long-term change in solar and geomagnetic activity.
Professional experience	2000-present, Principal Scientific Officer (Grade 7), British Antarctic Survey. 1995-2000, Senior Scientific Officer, British Antarctic Survey. 1991-1995, Higher Scientific Officer, British Antarctic Survey. 1990-1991, Royal Society Post-doctoral Fellowship in Physics.
Current Responsibilities	Member of Climate Programme, British Antarctic Survey. Member of the CHemical Aeronomy in the Mesosphere and Ozone in the Stratosphere (CHAMOS) science team. International Union of Radio Science (URSI) representative to the Scientific Committee on Antarctic Research, an inter-disciplinary committee of the International Council for Science. Principal investigator (with C. J. Rodger) of the Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK).
Relevant Past & Current Projects	**FP7-SPACE-SPA.2010.2.3.1 Grant 263218**: PLASMON - A new, ground based data-assimilative modeling of the Earth's plasmasphere – a critical contribution to Radiation Belt modeling for Space Weather purposes. 2011-2014
Selected Publications related to the Proposal	Clilverd, M A, C J Rodger, R J Gamble, Th Ulich, T Raita, A Seppälä, J C Green, N R Thomson, J A Sauvaud, and M Parrot, Ground-based estimates of outer radiation belt energetic electron precipitation fluxes into the atmosphere, J. Geophys. Res., 115, A12304, doi:10.1029/2010JA015638, 2010.

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Magnetospheric physics, especially in

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Principal Investigator**,** Study of Pc4&5 ULF pulsations in the inner magnetosphere: THEMIS observation, NASA HGI program, 2010.

Publications (Selected)

Liu, W., T. E. Sarris, X. Li, Q. - G. Zong, R. Ergun, V. Angelopoulos, and K. H. Glassmeier (2011), Spatial structure and temporal evolution of a dayside poloidal ULF wave event, Geophys. Res. Lett., 38, L19104, doi:10.1029/2011GL049476.

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