Proposal for an ISSI International Team Project 2012

Particle acceleration at plasma jet fronts in the Earth's magnetosphere

Team leader: Alessandro Retinò

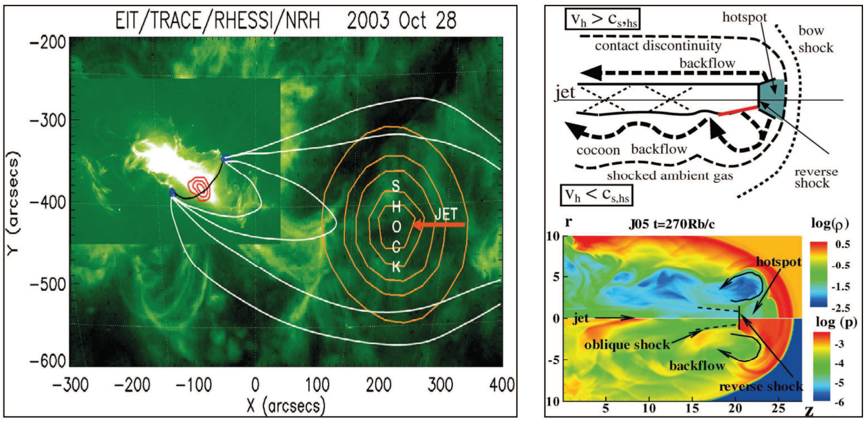
Abstract

We propose a team of 12 scientists to study particle acceleration at plasma jet fronts in the Earth's magnetosphere. The main goal is to identify the different ion and electron acceleration mechanisms at/around fronts and to establish which the most efficient ones are. Plasma jets and associated particle acceleration are very important in many astrophysical environments but can be studied in detail only in the magnetosphere, where high-resolution measurements of particle distribution functions and electromagnetic fields are available in situ. To achieve the proposed goal, we will combine multi-spacecraft ESA/Cluster and NASA/Themis in situ observations with models and numerical simulations (MHD, kinetic). We plan to have two meetings: the first in fall 2012 and the second in spring 2013. The outcome of the team activity is expected to be at least three publications: (1) one observational paper using Cluster and/or Themis data, (2) one paper on the comparison between observations and simulations, (3) one review paper summarizing our understanding of jet front acceleration mechanisms in the Earth's magnetosphere and discussing the applicability of such mechanisms to other planetary magnetospheres and possibly remote plasma environments.

1. Research project

1.1 Scientific rationale

Jets in astrophysical plasmas. High-speed collimated plasma flows, usually referred to as jets, are common in the universe and play a key role for the dynamics of many astrophysical plasmas. Examples where jet physics is important are reconnection in planetary magnetospheres [3,4,12,13] and solar flares [17,28] and plasma interactions in distant objects, e.g. in astrophysical jets [5,8,18]. A fundamental aspect of jet physics concerns the interaction of jet fronts with ambient plasma/obstacles and the acceleration of particles resulting from such interaction. The interaction of jets with ambient plasma/obstacles leads to the deceleration and eventually the braking of jets, resulting in the dissipation of their kinetic energy into electromagnetic energy. This leads in turn to the creation of electric fields and waves that can cause strong particle acceleration. Two examples are illustrated in Fig. 1. The first, Fig 1a, is the hard X-ray emission from loop-top sources during flares, which is believed to be produced by energetic electrons accelerated when the reconnection jet collides with the loop plasma in front of it [17]. The second is the formation of strong shocks resulting from the interaction of jets from compact objects with the ambient plasma [18], which can result in high-energy particle acceleration [8].



(a) (b)

Figure 1. (a) Solar observations suggesting that the outflow jets from reconnection regions can establish a standing fast mode shock, which can be the source of the energetic electrons produced during flares. The non-thermal (blue) and thermal (red) hard X-ray source observed by RHESSI and the location of the termination shock are overlaid on the EUV image from SOHO and TRACE (adopted from [17]) (b) Top: cartoon of the path of astrophysical jet and its backflow (adopted from [18]). Two cases are shown: the jet front in the upper/lower half is faster/slower than the local sound speed at the hotspot. The backflow is quasi-straight in the former case while is bent in the latter case. The backflow thermally expands sideways interacting with the shocked ambient gas. An oblique shock sometimes appears (red line). Bottom: density and pressure contours corresponding to the cartoon in the top lower-half (bent backflow).

The Earth's magnetosphere as universal laboratory. Understanding the basic physics of jet fronts and associated particle acceleration from an experimental point of view requires high-resolution in situ measurements of electromagnetic fields and particle distribution functions at jets fronts. In particular, multi-point observations are crucial to determine the orientation and motion of jet fronts and to distinguish between spatial and temporal effects. At present, such observations are only available in the Earth's magnetosphere through ESA/Cluster and NASA/Themis spacecraft. In addition, models and simulations are required to guide the interpretation of data that are usually limited to brief samplings of the acceleration regions. Beyond their direct application, e. g. to substorms physics, results from the Earth's magnetosphere are important because they may be exported to other planetary magnetospheres, where in situ measurements are typically less detailed, and possibly also to remote astrophysical environments, where in situ measurements are not possible.

Plasma jets in the Earth's magnetosphere. Transient and localized plasma jets play a major role in the Earth's magnetosphere [4]. Such jets are very often created by localized/transient reconnection in the magnetotail current sheet, although other generation mechanisms e.g. current disruption can also be important [16]. As jets propagate toward the Earth, their velocity decreases due to the interaction with the ambient plasma and eventually they dissipate upon collision with the Earth's dipole field. A significant deceleration of jets occurs at a distance 10-15 R_E [14, 20, 26] in the so-called *jet braking region*. The actual location at which jets eventually dissipate is not yet understood. The typical configuration of reconnection jet fronts propagating in the magnetotail and interacting with the Earth's dipole is shown in Figure 2.

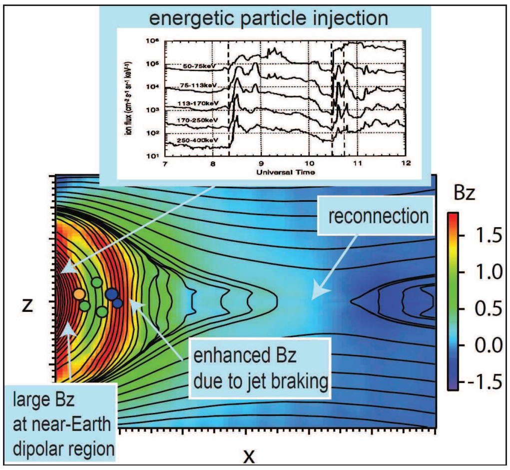


Figure 2. Simulated magnetic field lines and Bz distribution is shown, associated with the collapse of the inner magnetosphere due to jet braking (adopted from [7]). Typical observations of energetic proton injection events from a geosynchronous satellite are shown in the upper panel (adopted from [6]).

Particle acceleration at jet fronts in the magnetosphere. The jet front, the boundary separating jetting from ambient plasma, is a place where important particle acceleration occurs. The jet front usually corresponds to a sharp increase of the vertical magnetic field component Bz and is often referred to as *dipolarization front*. Jet fronts form when the outflowing reconnection jets starts to interact with the pre-existing ambient plasma and compress ambient magnetic flux tubes, as indicated in Fig. 2. The region of compressed magnetic field in the vicinity of the jet front is usually referred to as *magnetic flux pile-up region*.

At large temporal and spatial scales, MHD simulations with test particles indicate that acceleration at jet fronts/pile-up regions results from adiabatic betatron and Fermi mechanisms within large-scale magnetic flux tubes associated to fronts [1] and this prediction has been confirmed by observations [1,9]. Similar acceleration is also invoked in other environments, e.g. solar flares [27]. In some cases jet fronts can deform upon propagation and get fragmented due to MHD instabilities [21,29], eventually resulting in the formation of turbulent structures (e.g. thin current sheets, small-scale islands) that can contribute to particle acceleration [10,22,23].

On the other hand recent Cluster [14,19,32] and Themis [24,25] spacecraft observations have shown that jet fronts can be very thin. An example of such thin jet front is shown in Figure 3, where the temporal variation of Bz is observed by three Themis spacecraft. Thin jet fronts have been shown to be tangential discontinuities [14,25] separating hot jetting plasma from colder and denser ambient plasma. Strong electric fields forming in these thin layers, having typical spatial scale of the order of ion scales or below, can accelerate ions and electrons to non-thermal energies [25], as shown in Figure 3. For this case, the size of the front layer is between ion and electron scales and acceleration mechanisms for ions and electrons are different, as indicated by the difference in their pitch-angle distributions. Preliminary observations suggest that ions can be accelerated around jet fronts by the motional electric field [31] while electrons with smaller gyroradius can also be scattered and accelerated by strong lower hybrid and whistler waves [14,15,30] that exist at jet fronts.

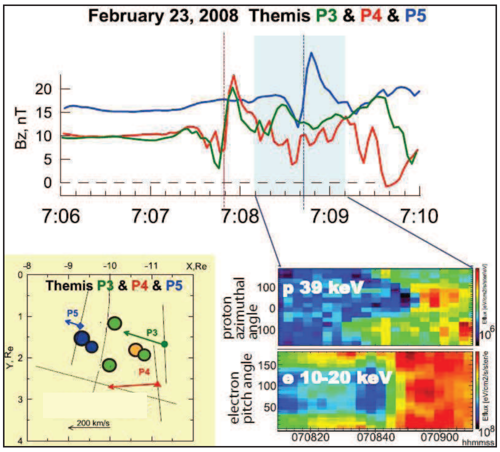


Figure 3. THEMIS three inner spacecraft observations of thin jet fronts (adopted from [25]). Enhanced energetic particle flux is identified at jet fronts where sharp changes in Bz occur. Energetic ions having larger gyroradii respond differently than electrons, due to the finite thickness of the boundary.

Strong acceleration also occurs when decelerated jets eventually interact with the Earth's dipole and stop/dissipate in the jet braking region. Test particle calculations in MHD simulations [6] suggest that the acceleration is consequence of the strong large-scale inductive electric field associated with the rapid change from tail-like to dipolar magnetic field topology. On the other hand recent Cluster observations in the braking region have provided evidence of small-scale filamentary current structures (having typical scale of ion gyroradius and below) that are associated with enhanced energetic particle fluxes [2,19,32], suggesting that non-MHD processes can also be important for particle acceleration therein. Observations show that in some cases such structures can evolve into shock waves [32] where stronger electron acceleration could be achieved through shock acceleration mechanisms, e.g. non-adiabatic surfatron mechanism [11]. The existence of shocks in the braking region is also invoked for other distant environments e.g. solar flares [17] and astrophysical jets [18]. Other mechanisms such as current disruption are also sometimes invoked in this region to account for enhanced particle fluxes [16].

Further important issues related to jet fronts are the relationship between the near-Earth braking region and the *injection region* (where particle are eventually injected into the inner magnetosphere) and which are the auroral signatures of jet-front accelerated particles. These aspects are still rather poorly understood.

1.2 Goals of the project.

Despite of the observations and simulations discussed above, the understanding of ion and electron acceleration mechanisms at jet fronts is still limited and much more work is required. The *main goal* of this project is to study in detail such mechanisms in the Earth's magnetosphere and to establish which the most efficient ones are. For this purpose, we will combine multi-spacecraft ESA/Cluster and NASA/Themis in situ observations in the magnetosphere with models and numerical simulations (MHD, kinetic). The foreseen typical configuration is that of jets produced by magnetic reconnection in the magnetotail and interacting with ambient plasma and obstacles (e.g. the dipolar magnetic field) while propagating towards the Earth. However other possible configurations could be also considered, e.g. those associated to ballooning instability or current disruption. We also plan to include data from other planetary magnetospheres, e.g. Saturn's magnetosphere. These data have typically lower resolution than those from the Earth's magnetosphere, however they can provide plasma parameters and boundary conditions (e.g. ion species, plasma beta, flow patterns, etc.) that are not available in near-Earth space and that can be important for a better understanding of the acceleration mechanisms.

Key scientific questions are:

1. what is the relative importance of adiabatic Fermi/betatron compared to non-adiabatic acceleration (wave/turbulence, shock-like, etc.) at jet fronts, for both ions and electrons?
2. what are the differences between ion and electron acceleration at jet fronts?

3. what are the typical properties (spectral indexes, pitch-angle distributions, etc.) of accelerated particles for the major acceleration mechanisms?
4. how the acceleration mechanisms depend on different boundary conditions (jet velocity, front layer size, laminar vs. turbulent jet fronts, substorm vs. storm times, etc.)

Additional scientific questions may also be addressed, depending on the time schedule:
1. how particles accelerated at jet fronts are later injected into the inner magnetosphere?
2. which are the auroral signatures of jet front acceleration?
3. what is the importance of reconnection compared to other mechanisms for producing plasma jets and energetic particles in the Earth's magnetosphere (and possibly in other planetary magnetospheres)?

1.3 Feasibility and timeliness

The team work would be feasible and very timely in terms of both data analysis and simulations. Many team members have strong expertise in data analysis and spacecraft instruments. Recent Cluster (2007-2008) and Themis (2010-2012) orbits crossed the magnetotail around 10-12 R_E where plasma jet braking/dissipation and strong particle acceleration occurs, allowing multi-point studies of the acceleration mechanisms. In particular Cluster is in a configuration with two spacecraft separated by ~ 30 km (sub-proton scales) while being located at ~ 10000 km (MHD/fluid scales) from the others, allowing for the first time a multi-scale study of the jet braking region. Cluster and Themis data are openly accessible. A specific observational campaign dedicated to jet fronts and braking region, led by A. Retinò (the leader of the proposed ISSI team), will be carried out in the summer/fall 2012 within the Cluster Guest Investigator program (http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=23160). Similar data will be available also in 2013 from both Themis and Cluster, due to the recent extension of the latter mission. Recent Cassini data are also providing very interesting results on jet/dipolarization fronts in Saturn's magnetosphere and these data can be used for studying the role of different boundary conditions/parameters on the acceleration mechanisms. Cassini data are available through some of the team members. Both particle-in-cell and MHD simulation codes by team members have been extensively used to study reconnection and substorm physics. Simulations of jet front interactions and associated particle acceleration have been very recently performed and further simulations are planned for the near future.

1.4 Importance

The physics of jet/dipolarization fronts and associated particle acceleration is one of the "hot topics" in present magnetospheric physics. Several well-cited papers were published in the last few years and the topic was/will be discussed in important international meetings (http://meetingorganizer.copernicus.org/EGU2011/session/6990 ; http://meetingorganizer.copernicus.org/EGU2012/session/9394). One session at 2011 AGU Fall meeting was fully devoted to jet fronts and particle acceleration (http://fallmeeting.agu.org/2011/scientific-program/session-search/787). The results expected from this team would contribute making important advances in the understanding of jet/dipolarization fronts formation and associated particle acceleration in the terrestrial magnetosphere and possibly in other planetary magnetospheres. The results from the team would also constitute an important background for the science of upcoming NASA/RBSP (radiation belt physics – 2012) and NASA/MMS (physics of reconnection at electron scales - 2014) missions for which particle acceleration is a major topic.

2. Schedule of the project

The team will have two major tasks, corresponding to the two planned meetings and associated work in between. During the first meeting, planned for fall 2012, we will make an overview of the latest science results on jet fronts and then make a priority list of topics from those already identified in section 1.2, which will be addressed through both data and simulations. Our first topic would likely be studying the relative importance of adiabatic Fermi/betatron compared to non-adiabatic acceleration (wave/turbulence, shock-like, etc.). We will select a few Cluster/Themis events to observationally study such issues and discuss in parallel how to carry out the comparison of data with the numerical simulations available in the group (MHD, kinetic). Possible approaches would be using MHD simulations to mimic the large-scale evolution of accelerated particles at jet fronts as jets propagate towards the inner magnetotail and using particle-in-cell simulations to mimic small-scale acceleration mechanisms at thin fronts. Preliminary lists of Cluster and Themis events already exist (produced by some of the team members) and will be hopefully extended before the first meeting. We also plan to use Cassini data to study jet front acceleration mechanisms at Saturn, aiming to understand how they operate under different boundary conditions than those at Earth. This task will be carried out by a few team members having expertise on both magnetospheres. A preliminary list of Cassini events is already available. In the second meeting, planned for spring 2013, we will discuss the results from our observational and simulation studies and then start drafting a review paper summarizing our understanding of jet front acceleration mechanisms in the Earth's magnetosphere, also discussing the applicability of such mechanisms to other planetary magnetospheres.

3. Expected output

We expect a minimum number of three publications as output of the team. The outcome of the work done during the first meeting and in the period between the two meetings is expected to be at least one observational paper and one paper on the comparison data-simulations, both to be submitted mid-2013. Following the second meeting, we will submit by the end of 2013 one review paper on our observational and theoretical results in the Earth's magnetosphere, also with applications to other magnetospheres. More specific simulations and observational papers may also be delivered by the team members during the project.

4. Added value by ISSI for the implementation of the project

The format of an ISSI team is ideal for the realization of the project. For the best outcome, we need to be a relatively small group of space plasma scientists working together on a well-defined topic. Also, it is important to combine expertise in data analysis with that in theory and simulations. Finally, having well-planned dedicated meetings with assignments in between would be very efficient.

5. List of confirmed team members

The following scientists have confirmed their intention to participate in the team (CVs are attached):

1. A. Retinò (team leader), *LPP-CNRS, France*: observations (reconnection, particle acceleration)
2. S. Badman, *ISAS-JAXA, Japan*: observations (aurora)
3. J. Birn, *Los Alamos National Laboratory, USA*: MHD simulations (reconnection, substorms)
4. M. Fujimoto, *ISAS-JAXA, Japan*: observations and PIC simulations (reconnection, substorms)
5. A. Greco*, Università della Calabria, Italy*: modeling (particle acceleration, turbulence)
6. C. Jackman, *University College London, UK*: observations (substorms, aurora)
7. Y. Khotyaintsev, *IRF-Uppsala, Sweden*: observations (reconnection, particle acceleration)
8. O. LeContel, *LPP-CNRS, France*: observations (substorms)
9. P. Pritchett, *UC Los Angeles, USA:* PIC simulations (reconnection, substorms)
10. A. Runov, *UC Los Angeles, USA*: observations (reconnection, substorms)
11. V. Sergeev, *Univ. St. Petersburg, Russia*: observations (reconnection, substorms)
12. B. Zieger, *Boston University, USA*: observations (substorms) and MHD simulations

The team members have well-established expertise covering all the aspects of the proposal.

6. Required facilities

We require standard ISSI facilities: one meeting room with projector, internet connection, access to the library and access to coffee/tea break facilities.

7. Financial support

We require standard ISSI financial support (hotel, per-diem) for two meetings for 12 team members plus 1-2 young scientists. Funding to cover travel costs is under the responsibility of the team members (except for the team leader).

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[3] Badman, S. et al., *Cassini observations of ion and electron beams at Saturn and their relationship to infrared auroral arcs*, JGR, 2012
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Education:

2007	PhD 'Solar wind influences on Saturn's magnetospheric and auroral dynamics', University of Leicester, UK.
2004	MPhys (1st class Honours) 'Physics with space science and technology with a semester in Australia', University of Leicester, UK.

Research Positions:

Jan 2010 – present	JAXA International Top Young Fellow, Department of Space Plasma Physics, ISAS, Japan.
Oct 2007 – Jan 2010	Research Associate in solar-planetary physics in the Radio and Space Plasma Physics Group at the University of Leicester, UK.

Research Team Membership and Responsibilities:

Cassini VIMS auroral representative for observation planning and design
Member of Cassini MAG-VIMS instrument collaboration team.
Member of International Space Science Institute (ISSI) Team on the Auroras of the Outer Planets.
Co-investigator of HST Programs GO 11984 (Observing Saturn's high latitude polar auroras, 2009), GO 12176 (Long term observations of Saturn's northern auroras, 2011 – 2013).
Co-investigator of Subaru Program S11B-073 (Jovian H3+ and H2 auroras: Energy transfer between neutrals and plasma).
Co-investigator of NIIHAMA project: Monitoring Jupiter's H3+ auroras.

Awards:

2010 – 2013	JAXA International Top Young Fellowship
2011	IUGG Early Career Researcher Grant, Melbourne
2009	Europlanet Young Scientist Travel Award for MOP meeting, Cologne
2008	Rishbeth Prize for best oral presentation at the national MIST meeting (Belfast).
2000	Velan scholarship for undergraduate studies (University of Leicester).

Professional Membership:

Fellow of the Royal Astronomical Society, Member of the American Geophysical Union.

Journal Responsibilities and Experience:

2012 – present	Associate Editor for AGU Journal of Geophysical Research - Space Physics.
2007 – present	Reviewer for *Ann. Geophys., J. Geophys. Res., Geophys. Res. Lett., Magnetotail Physics* (book), *AGU Monograph*.

Research Interests:

Magnetospheric and auroral dynamics in the solar system. Diagnosing the transfer of energy from the Sun to planetary environments. Use of Cassini spacecraft in situ and remote sensing data at Saturn. Interpretation and comparison of auroral emissions at ultraviolet, infrared and radio wavelengths from the outer planets.

Relevant Publications:

- **Badman, S.V.**, et al. (2012), Cassini observations of ion and electron beams at Saturn and their relationship to infrared auroral arcs, *J. Geophys. Res*, 117, doi:10.1029/2011JA017222.
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1982 - 2012: Technical Staff Member at Los Alamos.
1992-2003: Space Physics Focus Leader, Inst. Geophys. Plan. Physics at Los Alamos.
1980: Visiting Staff Member at Los Alamos
1973 - 1982: Scientific Employee, Ruhr-University Bochum, Germany

(c) Selected Publications (of more than 220):

Birn J., R. Nakamura, E. Panov, and M. Hesse, Bursty bulk flows and dipolarization in MHD simulations of magnetotail reconnection, *J. Geophys. Res.*, 116, A01210, doi:10.1029/2010JA016083, 2011.

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Birn, J., J. F. Drake, M. A. Shay, B. N. Rogers, R. E. Denton, M. Hesse, M. M. Kuznetsova, Z. W. Ma, A. Bhattacharjee, A. Otto, and P. L. Pritchett, Geospace Environment Modeling (GEM) magnetic reconnection challenge, *J. Geophys. Res.*, *106*, 3715, 2001.

Awards:

Fellowship of the American Geophysical Union

Los Alamos National Laboratory Fellow

Professional Experience:

J. Birn combines extensive experience in analytical theory, numerical modeling, and data analysis. His research experience includes three-dimensional equilibrium theory, development of three-dimensional MHD codes, equilibrium codes, test particle codes, and applications to magnetotail and solar corona dynamics; MHD stability theory, convection theory for magnetospheric and other space applications; data analysis relating to magnetospheric dynamics. He has published more than 240 refereed papers in these areas of research.

Resume of Dr. Masaki Fujimoto

March 1, 2012

Name	Masaki Fujimoto
Date of Birth	December 4, 1964, in Osaka, Japan
Present Position	Professor Solar System Sciences Division, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (JAXA)

Representative examples of Present Appointments

Division Director, Solar System Sciences Division, ISAS/JAXA
Geotail Project Scientist, JAXA
BepiColombo MMO Project Scientist, ISAS/JAXA
Chair, Committee for 1st International AO for HAYABUSA Sample Investigation
Secretary, Steering Committee for Space Science, ISAS/JAXA
Editor, Journal of Geophysical Research, Space Physics

Academic Background

1992.3	Degree of Doctor, Faculty of Science, University of Tokyo
1989.3	Master of Science, Faculty of Science, University of Tokyo
1987.3	Bachelor of Science, Faculty of Science, University of Tokyo

Professional Career

2006.6 ~ Present	Adjunct Professor, University of Tokyo
2006.4 ~ Present	Professor, ISAS/JAXA
1196.4 ~ 2006.3	Associate Professor, Tokyo Inst. Tech.
1992.4 ~ 1996.3	Assistant Professor, Nagoya University

Fields of Scientific Study: Space Plasma Physics

a) Space plasma physics via numerical simulations, from a planetary system formation process to kinetic instabilities.
b) Space plasma physics via spacecraft data analysis, with special emphasis on reconnection, plasma transport, and multi-scale coupling.

Selected Publications:

M. Fujimoto, et al., Observations of earthward streaming electrons at the trailing boundary of a plasmoid, Geophys. Res. Lett., 24, 2893, 1997.

M. Fujimoto, et al. Tailward electrons at the lobe-plasma sheet interface in the near-Earth tail crossed upon dipolarizations, J. Geophys. Res., 106, 21,255, 2001.

T. Nagai, M. Fujimoto, R. Nakamura, W. Baumjohann, A. Ieda, I. Shinohara, S. Machida, Y. Saito, and T. Mukai, Solar wind control of the radial distance of the magnetic reconnection site in the magnetotail, J. Geophys. Res., 110, A09208, doi:10.1029/2005JA011207, 2005.

M. Fujimoto, W. Baumjohann, K. Kabin, R. Nakamura, J. A. Slavin, N. Terada, L. Zelenyi: Hermean magnetosphere-solar wind interaction, *Space Sci. Rev., 132*, 529-550, 2007.

M. Oka, M. Fujimoto, T. K. M. Nakamura, I. Shinohara, and K.-I. Nishikawa, Magnetic Reconnection by a Self-Retreating *X* Line, Phys. Rev. Lett. 101, 205004 (2008)

M. Fujimoto, Y. Tsuda, Y. Saito, I. Shinohara, T. Takashima, A. Matsuoka, H. Kojima, and Y. Kasaba, The SCOPE Mission, AIP Conf. Proc. Volume 1144, pp. 29-35 (2009)

Khotyaintsev, Y.V., A. Vaivads, M. Andre, M. Fujimoto, et al., Observations of Slow Electron Holes at a Magnetic Reconnection Site, Phys Rev Lett, 105, 165002 (2010)

Fujimoto, M., I. Shinohara, and H. Kojima, Reconnection and Waves: A Review with a Perspective, Space Science Reviews, 160, 123-143, doi:10.1007/s11214-011-9807-7 (2011)

CURRICULUM VITAE ET STUDIORUM

Surname: Greco; Name: Antonella; Birth date: 28/04/1975; Birth place: Cosenza (Italy);
Work address: Università degli Studi della Calabria, Dipartimento di Fisica, Ponte P.Bucci, Cubo 33B, 87030 Rende (CS) Italy; Tel.: +39-984-496132 (work); e-mail: antonella.greco@fis.unical.it

Educational Background:

- Degree in Physics, achieved on 15th of May 1998 at University of Calabria with scores 110 cum lode; title of the thesis: *The study of ion transport in the Earth Magnetotail: superdiffusive and supeballistic transport regimes* (Supervisors: Prof. P. Veltri, Prof. G. Zimbardo).
- PhD degree in Physics achieved on 30th of January 2002 at University of Calabria; title of the thesis: *Particle transport processes in astrophysical plasmas* (Supervisor: Prof. P. Veltri).
- PostDoc position at University of Calabria from 1th of November 2001 to 31th of October 2004
- Actual position: Researcher since 3/01/2005 at University of Calabria

Time periods spent abroad

- Spatial Reasearch Institute of Moscow, from 06/05/2006 to 06/26/2006. Program title: *The role of electrons dynamics in the magnetotail current sheet and comparison with observations.*
- Bartol Research Institute in Delaware, USA, from 02/15/2008 to 05/30/2008 as visiting professor.
  Program title: *Problems of turbulence, particle acceleration and diffusion and related topics in plasma space physics.*

Reasearch Interests:

Non-linear dynamical system; non-Gaussian statistics; Levy random walks; anomalous particle transport; astrophysical and space plasmas: solar wind, magnetosphere; magnetic turbulence.

Most relevant pubblications for the proposal:

1) Perri S. , Zimbardo G. , Greco A. , On the energization of protons interacting with 3D time dependent electromagnetic fields in the Earth's magnetotail. Journal of Geophysical Research, 2011, Vol. 116, n. A0521.
2) Zimbardo G. , Greco A. , Sorriso-valvo L. , Perri S. , Voros Z. , et al., Magnetic Turbulence in the Geospace Environment. SPACE SCIENCE REVIEWS, 2010, Vol. 156, pp. 89-134.
3) Dalena S. , Greco A. , Zimbardo G. , Veltri P. , The role of oxygen ions in the formation of a bifurcated current sheet in the magnetotail. Journal of Geophysical Research, 2010, Vol. 115, n. A03213.
4) Dolgonosov M. , Zimbardo G. , Greco A. , Influence of the electric field perpendicular to the current sheet on ion beamlets in the magnetotail. Journal of Geophysical Research, 2010, Vol. 115, n. A02209 .
5) Greco A. , Perri S. , Zimbardo G. , Stochastic Fermi acceleration in the magnetotail current sheet: a numerical study. Journal of Geophysical Research, 2010, Vol. 115, n. A02203.
6) Perri S. , Greco A. , Zimbardo G. , Stochastic and direct acceleration mechanisms in the Earth's magnetotail. Geophysical Research Letters, 2009, Vol. 36, n. L04103.
7) Greco A., De Bartolo R., Zimbardo G., Veltri P., A 3D kinetic-fluid numerical code to study the equilibrium structure of the magnetotail: the role of electrons in the formation of the bifurcated current sheet. Journal of Geophysical Research, 2007, Vol. 112, n. A06218.
8) Greco A., Taktakishvili A.L., Zimbardo G., et al., Ion transport and Levy random walk across the magnetopause in the presence of magnetic turbulence. Journal of Geophysical Research, 2003, Vol. 108, n. 1395.
9) Greco A., Taktakishvili A.L., Zimbardo G., et al., Ion dynamics in the near-Earth magnetotail: Magnetic turbulence versus normal component of the average magnetic field. Journal of Geophysical Research, 2002, Vol. 107, n. 126.

Name: Dr Caitriona Jackman

Previous experience:
Feb-Sept 2002 Cassini Research Assistant, Mullard Space Science Laboratory, UK
2003-2006: PhD, University of Leicester, Leicester, UK
2006-2010: Research Associate, Imperial College London

Current position: Research Fellow, University College London. I hold a Leverhulme Trust Early Career Fellowship and a Royal Astronomical Society Fellowship, 2011-2014.

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Scientific interests: Large scale dynamics of planetary magnetotails, magnetic reconnection, auroral responses to magnetospheric dynamics; Large-scale heliospheric structure upstream of outer planets

Space Missions: Member of the Cassini Magnetometer team. Part of the Saturn Target Working Team (TWT) for future Cassini mission planning.

Relevant Publications:

Jackman, C.M., Saturn's radio emissions and their relation to magnetospheric dynamics, in *Planetary Radio Emissions VII*, edited by H.O. Rucker, W.S. Kurth, P. Louarn, and G. Fischer, Austrian Academy of Sciences Press, Vienna, 1-12, 2011.

Jackman, C. M., J. A. Slavin, and S. W. H. Cowley, Cassini observations of plasmoid structure and dynamics: Implications for the role of magnetic reconnection in magnetospheric circulation at Saturn, J. Geophys. Res., 116, A10212, doi:10.1029/2011JA016682, 2011.

Jackman, C. M., C. S. Arridge, J. A. Slavin, S. E. Milan, L. Lamy, M. K. Dougherty, and A. J. Coates, In situ observations of the effect of a solar wind compression on Saturn's magnetotail, J. Geophys. Res., 115, A10240, doi:10.1029/2010JA015312, 2010

Arridge, C.S., H.J. McAndrews, C.M. Jackman, C. Forsyth, A.P. Walsh, E.C. Sittler, L.K. Gilbert, G.R. Lewis, C.T. Russell , A.J. Coates, M.K. Dougherty, G.A. Collinson, A. Wellbrock, D.T. Young, Plasma electrons in Saturn's magnetotail: structure, distribution and energisation, *Planet. Space. Sci.*, 57 (14-15), 2032-2047, doi:10.1016/j.pss.2009.09.007, 2009.

McAndrews, H.J. M.F. Thomsen, C.S. Arridge, C.M. Jackman, R.J. Wilson, M.G. Henderson, R.L. Tokar, K.K. Khurana, E.C. Sittler, A.J. Coates, M.K. Dougherty, Plasma in Saturn's nightside magnetosphere and the implications for global circulation, *Planet. Space. Sci*, 57 (14-15), 1714-1722, doi:10.1016/j.pss.2009.03.003, 2009.

Jackman, C.M., L. Lamy, M.P. Freeman, P. Zarka, B. Cecconi, W.S. Kurth, S.W.H. Cowley, M.K. Dougherty, On the character and distribution of lower-frequency radio emissions at Saturn, and their relationship to substorm-like events, *J. Geophys. Res.*, 114, A08211, doi:10.1029/2008JA013997, 2009.

Jackman, C.M., C.S. Arridge, N. Krupp, E.J. Bunce, D.G. Mitchell, W.S. Kurth, H.J. McAndrews, M.K. Dougherty, C.T. Russell, N. Achilleos, A.J. Coates, G.H. Jones, A multi-instrument view of tail reconnection at Saturn, *J. Geophys. Res.*, 113, A11213, doi:10.1029/2008JA013592, 2008.

Jackman, C.M., C.T. Russell, D.J. Southwood, C.S. Arridge, N. Achilleos, and M.K. Dougherty, Strong field dipolarizations in Saturn's magnetotail: In situ evidence of reconnection, *Geophys. Res. Lett.*, 34, (11), Art. No. L11203, 2007

Jackman, C.M., and S.W.H. Cowley, A model of the plasma flow and current in Saturn's polar ionosphere under conditions of strong Dungey cycle driving, *Ann. Geophysicae*, 24, 1029-1055, 2006.

Cowley, S.W.H., S.V. Badman, E.J. Bunce, J.T. Clarke, J.C. Gerard, D. Grodent, C.M. Jackman, S.E. Milan, T.K. Yeoman, Reconnection in a rotation-dominated magnetosphere and its relation to Saturn's auroral dynamics, *J. Geophys. Res.*, 110, A02201, doi:10.1029/2004JA010796, 2005.

Brief Curriculum Vitae for Yuri Khotyaintsev

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Personal:
Born January 21, 1976 in Kyiv, Ukraine.
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Education:
M. Sci. in Physics, 1997, Kyiv Shevchenko University.
Ph. D. in Space Physics, 2003, Uppsala University.

Employment:
1998 – 2003, PhD student at Swedish Institute of Space Physics, Uppsala.
2003 – 2008, Scientist, Swedish Institute of Space Physics, Uppsala. Analysis of the EFW data for the Cluster Active Archive (CAA).
2008 to present, Research Fellow, Swedish Institute of Space Physics, Uppsala.

Experience in Space Science Missions:
F1, F2, F4, F7 instruments, Freja (scientific analysis)
EFI, MFE instruments, Polar (scientific analysis)
EMMA, LINDA instruments, Astrid-2 (scientific analysis)
EFW instrument, Cluster, Co-Inverstigator, responsible for production of the EFW data for the CAA.
RPW, SolarOrbiter, Co-Inverstigator
FIELDS/SDP, MMS, responsible for the SDP science data production

Other relevant experience:
1999-2003 Development of Orbit Visualization Tool (OVT, http://ovt.irfu.se).
2005-2007 Member of an international team at the International Space Science Institute (ISSI) studying relationship between the reconnection and turbulence.
2008-2011 Team leader of an international team at ISSI "Magnetic reconnection and particle energization: synergy of in situ and remote observations", http://www.issibern.ch/teams/synergy_remote/

Professional Societies:
Member of American Geophysical Union

Selected publications:
• Khotyaintsev, Yu.V., C.M. Cully, A. Vaivads, M. André, and C. J. Owen, Plasma Jet Braking: Energy Dissipation and Non-Adiabatic Electrons, Phys. Rev. Lett., 2011, 106, 165001, 2011.
• Khotyaintsev, Yu.V., A. Vaivads, M. André, M. Fujumoto, A. Retino, and C. J. Owen, Observations of slow electron holes at a magnetic reconnection site, Phys. Rev. Lett., 105, 165002, 2010.
• Khotyaintsev, Y., P.-A. Lindqvist, A. I. Eriksson and M. André, The EFW Data in the CAA, The Cluster Active Archive, Studying the Earth's Space Plasma Environment. Edited by H. Laakso, M.G.T.T. Taylor, and C. P. Escoubet. Astrophysics and Space Science Proceedings, Berlin: Springer, p.97-108, 2010.
• Khotyaintsev, Yu. V., A. Vaivads, A. Retino, M. André, C. J. Owen, H. Nilsson, Formation of Inner Structure of a Reconnection Separatrix Region, Phys. Rev. Lett., Vol. 97, 205003, 2006.
• Vaivads, A., Y. Khotyaintsev, M. André, A. Retinò, S. C. Buchert, B. N. Rogers, P. Décréau, G. Paschmann, T. D. Phan, Structure of the Magnetic Reconnection Diffusion Region from Four-Spacecraft Observations, Phys. Rev. Lett., Vol. 93, 105001, 2004.

Full list of publications: http://www.cluster.irfu.se/yuri/publications.html

Olivier Le Contel

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Born in 1968 in Paris, France

Education:

- Ph.D. in Astrophysics and Space Technology 1997, University Paris VII–Denis Diderot
- M.A. in Astrophysics and Space Technology, 1992 University Paris VII–Denis Diderot (Observatory of Paris-Meudon)
- B. S. in Mathematics and Technology, 1986, Paris.

Employment:

- Permanent Researcher, Laboratoire de Physique des Plasmas (LPP), CNRS, 2009 – Present.
- Permanent Researcher, Centre d'étude des Environnements terrestre et planétaires (CETP), CNRS, 2000 – 2008.
- Postdoctoral fellowship, Centre d'études des Environnements Terrestres et Planétaires, 1998-2000.
- Temporary assistant professor (ATER), University of Versailles-St Quentin, 1997-1998.

Relevant experience:

- CoI on CLUSTER STAFF-SC and DSP STAFF-SC,
- CoI on THEMIS SCM,
- CoI on MMS SCM,

Dr Le Contel is CoI on THEMIS SCM and MMS SCM experiments at LPP. He is (or has been) involved in the fabrication, calibration and management for these instruments as well as in science data analysis.

Research Activities
O. Le Contel is working on space physics and more particularly on magnetospheric substorms. His areas of interest are :

• Models of substorms
• Kinetic model of plasma transport in magnetic mirror confined plasma
• Solar wind interactions with the Earth's magnetosphere

Dr Le Contel has authored or co-authored about 45 articles in international refereed journals (see for more details http://www.lpp.fr/?Olivier-Le-Contel).

Recent relevant publications:

A. Roux, P. Robert, **O. Le Contel**, V. Angelopoulos, U. Auster, J. Bonnell, C.M. Cully, R.E. Ergun, and J.P. McFadden, A mechanism to heat electrons in the magnetopause current layer and adjacent regions, Annales Geophys., 29,p1-p12, doi: 10.5194/angeo-29-1-2011, 2011.
Le Contel O. et al,, Quasi-parallel whistler waves observed by THEMIS during near-earth dipolarizations, Annales Geophysicae, 27, 2259–2275, 2009.
Baumjohann W., Roux A., **Le Contel O.**, Nakamura R., Birn J., Hoshino M., Lui A.T.Y., Owen C., Sauvaud J.-A., Vaivads A., Fontaine D., and A. Runov, Dynamics of thin current sheets: Cluster observations, *Annales Geophysicae*, 25, 1365-1389, 2007.

Philip L. Pritchett

Philip L. Pritchett is a Research Physicist and an Adjunct Professor in the Department of Physics and Astronomy at the University of California, Los Angeles. He received his Ph.D. degree in theoretical physics in 1970 from Stanford University, where he held an NSF Graduate Fellowship and was an honorary Woodrow Wilson Fellow. He spent one year as a NATO Postdoctoral Fellow at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg, Germany and four years at Northwestern University doing research in elementary particle theory. Since 1975 he has been a member of the research staff of the plasma simulation and space plasma simulation groups at UCLA.

His current research interests lie in computational plasma physics with application to fundamental problems in magnetospheric physics. In recent years he has done extensive work on the electron-cyclotron maser instability and its application to the Earth's auroral kilometric radiation, the Kelvin-Helmholtz instability, collisionless reconnection in the magnetotail and at the dayside magnetopause, the problem of plasma sheet convection, acceleration of charged particles during magnetic reconnection, generalized interchange instabilities, and 3D particle simulations on massively parallel supercomputers.

He has served as Principal Investigator and Co-Investigator on numerous NASA and NSF grants in magnetospheric and auroral physics. Since 1986 he has served as the principal investigator on TeraGrid supported computational projects dealing with auroral kilometric radiation and collisionless dissipative processes in the magnetosphere.

Selected Relevant Publications

Pritchett, P.L., Electron-cyclotron maser instability in relativistic plasmas, *Phys. Fluids, 29,* 2919, 1986.

Pritchett, P.L., F.V. Coroniti, R. Pellat, and H. Karamabadi, Collisionless reconnection in two-dimensional magnetotail equilibria, *J. Geophys. Res., 96*, 11523, 1991.

Pritchett, P.L., F.V. Coroniti, and V.K. Decyk, Three-dimensional stability of thin quasi-neutral current sheets, *J. Geophys. Res., 101*, 27413, 1996.

Pritchett, P.L., and F.V. Coroniti, Drift ballooning mode in a kinetic model of the near-Earth plasma sheet, *J. Geophys. Res., 104,* 12289, 1999.

Pritchett, P.L., and F.V. Coroniti, Localized convection flows and field-aligned current generation in a kinetic model of the near-Earth plasma sheet, *Geophys. Res. Lett., 27*, 3161, 2000.

Pritchett, P.L., and F.V. Coroniti, Three-dimensional collisionless magnetic reconnection in the presence of a guide field, *J. Geophys. Res., 109*, A01220, 2004.

Pritchett, P.L., Externally driven magnetic reconnection in the presence of a normal magnetic field, *J. Geophys. Res., 110*, A05209, 2005.

Pritchett, P.L., The "Newton Challenge": Kinetic aspects of forced magnetic reconnection, *J. Geophys. Res., 110*, A10213, 2005.

Pritchett, P.L., Relativistic electron production during guide field magnetic reconnection, *J. Geophys. Res., 111*, A10212, 2006.

Pritchett, P.L., and F.V. Coroniti, Plasma sheet response to the ionosphere's demand for field-aligned current, *Geophys. Res. Lett., 34*, L12104, 2007.

Pritchett, P.L., Energetic electron acceleration during multi-island coalescence, *Phys. Plasmas, 15*, 102105, 2008.

Pritchett, P.L., and F.S. Mozer, Asymmetric magnetic reconnection in the presence of a guide field, *J. Geophys. Res., 114*, A11210, doi:10.1029/2009JA014343, 2009.

Pritchett, P.L., and F.V. Coroniti, A kinetic ballooning/interchange instability in the magnetotail, *J. Geophys. Res., 115*, A06301, doi:10.1029/2009JA014752, 2010.

Curriculum vitæ et studiorum
Alessandro Retinò

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Education
05/2007: PhD in Space and Plasma Physics, Uppsala University, Uppsala, Sweden
11/2002: M.Sc. *summa cum laude* in Astrophysics and Space Physics, University La Sapienza, Roma, Italy

Research positions
1/2012 – 3/2012: visiting researcher, ISAS-JAXA, Sagamihara, Japan
10/2010 – present: permanent researcher, Lab. de Physique des Plasmas - CNRS, St Maur des Fosses, France
10/2007 – 9/2010: junior scientist, Space Research Institute, Graz, Austria
6/2007 – 9/2007: postdoc - Swedish Institute of Space Physics Uppsala, Sweden
5/2006 – 8 /2006: visiting graduate student - Space Sciences Lab., University of California, Berkeley, USA
2/2003 – 5/2007: graduate student - Swedish Institute of Space Physics, Uppsala, Sweden

Research activity
Dr. Retinò is working in the field of space plasma physics, focusing on analysis and interpretation of *in situ* observations in solar system plasmas (solar wind, planetary magnetospheres) and on the comparison between observations and numerical simulations . His mayor areas of interest are :

- magnetic reconnection
- space plasma turbulence and relationship reconnection-turbulence
- mechanisms of particle acceleration

Dr. Retinò has a broad expertise in the analysis of spacecraft data (NASA/Polar, ESA/Cluster, NASA/Themis, ESA-NASA/Cassini) for both particles and electromagnetic fields. He participates to data and science preparation for upcoming NASA/MMS mission. Dr. Retinò is science co-I for the planned ESA/SolarOrbiter and NASA/SolarProbePlus missions. He is author of 35+ refereed articles in international journals and 15+ invited presentations at international conferences and workshops.

Selected publications

- **A. Retinò** et al., *Energetic Electron Acceleration in the Near-Earth Flow Braking Region: Cluster Multi-Scale Observations,* submitted to J. Geophys. Res.
- A. Vaivads, **A. Retinò** et al., *Suprathermal electron acceleration during reconnection onset in the magnetotail*, Ann. Geophys., 2011
- B. Zieger, **A. Retinò** et al., *Jet front-driven mirror modes and shocklets in the near-Earth flow-braking region*, Geophys. Res. Lett., 2011
- R. Nakamura, **A. Retinò** et al., *Evolution of dipolarization in the near-Earth current sheet induced by Earthward rapid flux transport*, Ann. Geophys., 2009
- **A. Retinò** et al., *Cluster observations of energetic electrons and electromagnetic fields with thin reconnecting thin current sheet in the magnetotail*, J. Geophys. Res., 2008
- **A. Retinò** et al., *In-situ evidence of magnetic reconnection in turbulent plasma*,Nature Physics, 2007

Andrei Runov
Curriculum Vitae

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Education:
Master Dgr. in Geophysics, St. Petersburg State University, 1993
PhD in Physics and Mathematics, St. Petersburg State University, 1996.

Scientific Career:
1984 - 1993: Undergraduate Student, Faculty of Physics, St. Petersburg State University, St. Petersburg, Russia
1993 - 1996: PhD Student, Department of Geophysics, Faculty of Physics, St. Petersburg State University
1996 - 1998: Programmer, Faculty of Physics, St. Petersburg State University
1998 - 2001: Teacher Assistant, Faculty of Physics, St. Petersburg State University
10/01/2001 – 09/15/2007: Scientist, Space Research Institute, Austrian Academy of Sciences, Graz, Austria
09/18/2007 – 07/31/2008: Associate Researcher, Step II, IGPP UCLA
08/01/2008 – 06/31/2010: Associate Researcher, Step III, IGPP UCLA
07/01/2010 – present: Researcher Step I, ESS UCLA

Research interests:
Space plasma physics, planet magnetospheres, auroral phenomena, plasma current sheets structure and dynamics, data analysis, modeling, particle measurements in space.
Current topics: 1. Study of the magnetotail plasma sheet structure and dynamics with multi-point measurements by THEMIS and ARTEMIS spacecraft. 2. Design of high-energy particle detector for low-orbiting micro-satellites (CubeSat)

Recent Publications:
Runov, A., V. Angelopoulos, X.-Z. Zhou , "Multi-point observations of dipolarization front formation by magnetotail reconnection", J. Geophys.Res., 117, 2012 (in press)
Runov, A., V. Angelopoulos, X.-Z. Zhou, X-J. Zhang, S. Li, F. Plaschke, J. Bonnell, "A THEMIS multi-case study of dipolarization fronts in the magnetotail plasma sheet", J. Geophys.Res., 116, A05216, doi:10.1029/2010JA016316, 2011.
Runov, A., V. Angelopoulos, M.I. Sitnov, V.A. Sergeev, R. Nakamura, Y. Nishimura, H.U. Frey, J.P. McFadden, D. Larson, J.Bonnell, K.-H. Glassmeier, U. Auster, M. Connors, C.T. Russell, and H.J. Singer, "Dipolarization fronts in the magnetotail plasmasheet", Planet. Space Sci., doi:10.1016/j.pss.2010.06.006, 2010.
Runov, A., V. Angelopoulos, M. I. Sitnov, V. A. Sergeev, J. Bonnell, J. P. McFadden, D. Larson, K.-H. Glassmeier, and U. Auster, "THEMIS observations of an earthward-propagating dipolarization front", Geophys. Res. Lett., 36, L14106, doi:10.1029/2009GL038980, 2009.

Curriculum Vitae **Victor Andreevich SERGEEV**

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Education and degrees

1966(9)-1972(1), Leningrad State University (geophysics)
1971(12): M.S. in geophysics, Dept. of Physics in the Leningrad State University
1975(01): Ph.D.(Cand.of Science) in geophysics from Leningrad State University
1990(02): Doctor of Science degree in geophysics from Leningrad State University

Scientific career and full-time employment:

1974-till present: research in the Laboratory of Magnetospheric Physics,
at the Institute of Physics and Physical Faculty, Leningrad State University:
- 1972(01) - 1974(05) Laboratory Assistant/Postgraduate Student
- 1974(05) - 1979(11) Junior Scientist
- 1979(11) - 1990(02) Senior Scientist
- 1990(02) - 1997(08) Leading Scientist
- 1997(08) - present Professor at Physical Faculty, St.Petersburg State University

International awards:

2004 and 2008 - citations for excellence in refereeing from American Geophysical Union
2008- Julius Bartels medal of European Geoscience Union for research in solar-terrestrial sciences

Speciality - Space Physics , Magnetospheric Physics
Investigation of natural processes with principal emphasize on the physics of substorm phenomena in the Earth's magnetotail. The approach based on :
- usage of multi-instrumental observations (different ground-based observations as well as spacecraft observations at low altitudes and in the magnetosphere),
- development of new monitoring techniques (numerical algorithms to define parameters of substorm current systems, parameters of magnetotail configuration etc)

Among specific areas of interest during last years there were:
- study of multiple impulsive (~1min scale) structure of substorm expansion phase; identification of the plasma bubbles and auroral streamers as manifestations of the BBFs;
- identification and study of thin current sheets in the magnetotail;
- study of steady magnetospheric convection events in the ionosphere and magnetosphere as rare but important ground states of the magnetotail;
- development and various applications of novel method of remote sensing of the magnetospheric configuration and magnetospheric modeling based on low altitude observations of isotropic boundaries of energetic particles.

Participation in International Projects:
- Coordinator of Ground-Based Observation working group and member of Scientific Committee of INTERBALL project (1985-2001);
- Member of CLUSTER Ground-Based Observation Working Group;
- Co-Investigator in FGM Double Star project;
- Co-Investigator in THEMIS project

Publications : >200 papers in refereed journals.

Curriculum Vitae

Name : Bertalan Zieger; **Born:** December 6, 1964, Miskolc, Hungary; **Citizenship:** Hungarian

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Education:

1997: Awarded **Ph.D. degree in Physics** with *eximia cum laude* (excellent) grade at the Space Physics Department of the University of Oulu, Finland.

1989: Received **M.S. degree in Geophysics** and English-Hungarian Professional Translation at the Loránd Eötvös University of Budapest (ELTE), Hungary.

Career/Employment:

Since March 2012: **Research Scientist** at the Center for Space Physics, Boston University, Boston, Massachusetts, USA

2009-2011: **Research Scientist** at the Space Research Institute, Austrian Academy of Sciences, Graz, Austria

2007-2009: **Visiting Assistant Research Scientist** at the Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, Michigan, USA

2002-2006: **Postdoctoral Fellow** at the International University Bremen (now known as Jacobs University Bremen), Bremen, Germany

1999-2000: **Postdoctoral Fellow** at the Danish Space Research Institute (now known as Danish National Space Center), Copenhagen, Denmark

1989-2001: Employed at the Geodetic and Geophysical Research Institute of the Hungarian Academy of Sciences, Sopron, Hungary, as **Assistant Research Fellow** (1989-1991), **Associate Research Fellow** (1992-1997), and **Senior Research Fellow** (1998-2001).

Specializations and research experience:

Space weather and space climate, the coupled interaction of the solar wind with planetary magnetospheres and ionospheres, and its global magnetohydrodynamic (MHD) simulation, CLUSTER and THEMIS multi-scale analysis of reconnection and dipolarisation events in the Earth's magnetotail, including the study of plasma jets and particle acceleration

Selected Publications:

Zieger, B., J. Vogt, K.-H. Glassmeier and T. I. Gombosi (2004), Magnetohydrodynamic simulation of an equatorial dipolar paleomagnetosphere, *J. Geophys. Res.*, 109, A07205

Zieger, B., J. Vogt, and K.-H. Glassmeier (2006) Scaling relations in the paleomagnetosphere derived from MHD simulations, *J. Geophys. Res.*, 111, A06203

Zieger, B. and K. C. Hansen (2008), Statistical validation of a solar wind propagation model from 1 to 10 AU, *J. Geophys. Res.*, 113, A08107

Zieger, B., K. C. Hansen, O. Cohen, et al. (2009), Upstream conditions at Mercury during the first MESSENGER flyby: Results from two independent solar wind models, *Geophys. Res. Lett.*, 36, L10108

Zieger, B., K. C. Hansen, T. I. Gombosi, and D. L. De Zeeuw (2010), Periodic plasma escape from the mass-loaded Kronian magnetosphere, *J. Geophys. Res.*, 115, A08208

Zieger, A. Retinò, R. Nakamura, W. Baumjohann, A. Vaivads, and Y. Khotyaintsev (2011), Jet front-driven mirror modes and shocklets in the near-Earth flow-braking region, *Geophys. Res. Lett.*, 38, L22103