Input to ”National Center for Planetary System Research”

Jan-Erik Wahlund, 10/19/2006.10.02

Background:
Input is needed from IRFU, Geology and Astronomy to gather strong (or weak) competence areas that can be the basis for a center of planetary research with partly financial support from “Linné-stöd” (excellent research environments from VR). My input consists of three research areas where collaborations are deemed promising, and a brief statement about my own competence area.

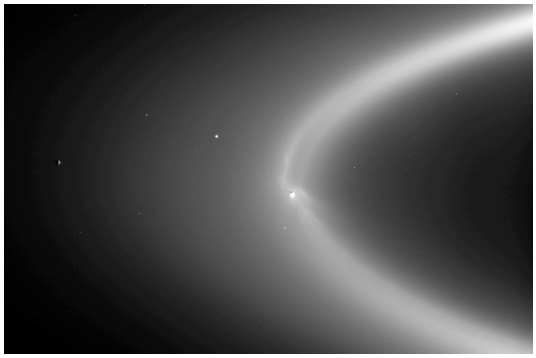
It should be noted that we have barely enough resources for the world leading research work we currently do, which means that additional resources are needed to promote the areas suggested here.

Ionization near planet forming disc regions (near e.g. T-Tauri stars)

- Knowledge of origin of (E)UV and particle radiation (acceleration processes)
  - Where, how much?
- Knowledge of the ionization processes of the neutral gas (in the disc) & Aeronomy
  - Gives a partially ionized plasma
- Knowledge of dust charging & dust-plasma coupling
  - Effects on dust formation & accretion

Related areas in my current research:

- Cassini observations of E-ring dust interaction with magnetospheric plasma disc



Plasma transport effects on dynamics of planet forming disc regions

- Knowledge of plasma dynamics and convection fields (**E**, **B**) and interaction with neutral medium
  - Momentum and energy exchange through collisions (ν_{in}, ν_{en})
  - Can a velocity shear develop in the disc? Important?
- Knowledge of dust-plasma coupling
  - Non-MHD approach needed
  - Effects on dust-dynamics
  - Effects on plasma dynamics (and neutral medium)

Early Earth’s Ionosphere/Atmosphere

Understanding of nitrogen-rich atmospheres is essential for understanding of the beginning and evolution of biological life, as we know it. Nitrogen-rich atmospheres can be found on the

planets Earth and Pluto, and on the planetary-sized moons Titan and Triton. Another example was probably early Mars.

The influence of the space plasma electrodynamic effects and the radiation environment determines the escape of volatiles from atmospheres and thereby their climate evolution, and it can trigger a chemistry of pre-biotic nature in nitrogen-rich atmospheres. A weakly reducing atmosphere of nitrogen, methane and perhaps water and carbon dioxide is a perfect environment for the production of complex organic molecules given an energy source that can break the strong covalent N_2-bond [*Miller*, 1998]. One obvious ionizing or photo-dissociating energy source is the solar UV radiation. In addition, planetary magnetospheres trap plasma and energetic charged particles of internal and solar wind origins on closed magnetic field lines, and therefore also contribute to the formation of ionospheres around atmospheric bodies inside them. The energy deposition of magnetospheric electrons and the solar radiation (and possibly other ionizing radiation like cosmic rays) are believed to act as a catalyst for the very complex organic chemistry occurring on Titan. Similar complex organic chemistry is believed to have played a crucial role for the origin of life on Earth where pre-biotic molecules leading to life evolved in a nitrogen-rich atmosphere [*Raulin & Owen*, 2002].

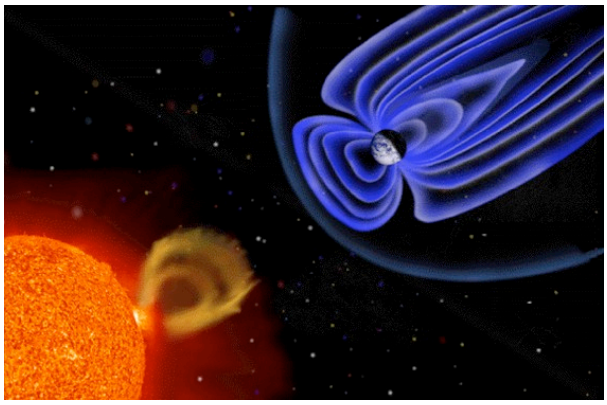
- Knowledge of possible neutral atmosphere for early Earth
- Knowledge of early solar (E)UV ionizing radiation
- Knowledge how ionosphere formation
- Knowledge in ion-molecule chemistry ⇒ Pre-biotic building blocks
- Knowledge in atmospheric escape mechanisms ⇒ Atmospheric evolution
- Astrobiological relevance?

Related areas in my current research:

- Cassini observations near Titan.

Own competence profile

- Data validation and analysis from spacecraft instruments and EISCAT radar
- Knowledge in spacecraft instrumentation for in-situ measurements (in particular various plasma related)
- Knowledge in management related to ESA, NASA, JAXA planetary missions
    - Involved in ESA Cosmic Vision and NASA Scout plans for the future
        - VEP (and VISP) to Venus
        - MAGNUM (and Solaris) to Mars
        - JME etc to Jupiter
- Large international contact network related to aforementioned activities



Scientific Competence:
Identify, model and understand the main processes in space plasmas.
Focus on the importance of micro-physical processes for large-scale phenomena.

- Solar-Terrestrial interactions in a broad sense
  - Solar (E)UV, Magnetospheric particle radiation - atmosphere
  - Solar wind – ionosphere/magnetosphere interactions
  - Planetary plasma escape processes and atmospheric evolution
- Plasma wave-particle interactions (energy and momentum exchange processes)
  - Alfvén wave energy transfer
  - Effects of ion acoustic like wave activity (low frequency broadband)
- Planetary ionospheres (in particular Earth's, Mars', Venus, Titans)
- Planetary magnetospheres (Earth's, Mercury, Jupiter, Saturn)
- Saturn E-ring and plasma disc (Enceladus), Io plasma torus
- Dusty plasma
- Astrobiology

Relevant experience in space missions:
Co-investigator, on the LINDA instrument on the Swedish Astrid-2 spacecraft project, 1997-1998
Co-investigator on the LAP instrument on ESA ROSETTA spacecraft project, 1996-present
Co-Investigator on the RWPS instruments on NASA/ESA Cassini/Huygens spacecraft project, 1992-present
Project manager for the Langmuir probe part of the Cassini/Huygens RPWS instruments, 1990-1992 and 1998-present
Project scientist of the ESA student mission LunarSat aimed for the Moon, which resulted in a complete spacecraft system design, project was unfortunately put down by the ESA member states at the ESA Council in 1999, 1997-2000
Co-Investigator on the SPEDE instrument on the ESA SMART spacecraft project,
Co-Investigator on the PWI (MEFISTO) instruments on ESA/JAXA BepiColombo spacecraft project
Project manager for the Uppsala part of PWI (MEFISTO) of the BepiColombo project,

Other relevant appointments:
Member, Working group on Auroral Alfvén wave processes, International Space Science Institute (ISSI), 1999-2000
Member of Europlanet belonging to the European Union 6th framework programme, 2004-present