Solar wind with Jupiter (Saturn) and aurorae: Science Case 4 applied to IDIS

Florian Topf
florian.topf@oeaw.ac.at

EuroPlaNet N2-N7 Meeting May 2-4, 2007

Introduction

Main Topics of Science Case 4 (1/3)

- Exploration of the configuration and dynamics of Saturn's magnetosphere; Interaction with solar wind, Titan and the icy satellites
- Analyzation of magnetospheric substorm-like activity at Saturn
- Investigation of hot plasma in the magnetosphere of Saturn
- Energetic neutral imaging of ring current, radiation and neutral clouds
- Study of rings current(s), plasma sheet and neutral clouds in the magnetosphere/magnetotail of Jupiter

Main Topics of Science Case 4 (2/3)

- Informations on the atmospheric composition and photochemistry of Saturn and Titan, history and nature of Saturn's rings
- Measurements of Saturn's/Jupiter's magnetic field directions and strength
- Energy and electric charge of particles originating from Saturn's ionosphere
- Exploration of Saturn's magnetosphere/ionosphere coupling; Magnetotail dynamics and structure
- Investigation of the magnetic state of Titan's body and atmosphere

Main Topics of Science Case 4 (3/3)

- Documentation of all titan-plasma flow interactions
- Investigation of radio and plasma waves emitted from Saturn's and Jupiter's magnetosphere, Titan's ionosphere and solar wind
- Measurement of the energy and angular distribution, composition, and stability of trapped radiation at Jupiter; Interaction of these particles with solar wind
- Informations on the flux, anisotropy and chemical composition of energetic particles in interplanetary space
- Generic investigations on Velocity, Composition and Temperature of solar wind

Cassini-Huygens

Summary:

International collaboration between NASA, ESA and ASI to study Saturn and it's biggest moon Titan; Investigations on other Moons of Saturn; Huygens probe landing on Titan

Ressources:

- http://www.mps.mpg.de/de/projekte/cassini/ Project homepage at MPS
- http://saturn.jpl.nasa.gov/home/index.cfm NASA JPL homepage
- http://www-pw.physics.uiowa.edu/plasma-wave/cassini/home.html University of Iowa linklist

Ressources (contd.):

- http://www3.imperial.ac.uk/spat/research/missions/space_missions/cassini/
  Project homepage at Imperial College
- http://www.mssl.ucl.ac.uk/www_plasma/missions/cassini.php
  Project homepage at MSSL
- solarsystem.dlr.de/Missions/cassini/index.shtml
  Project homepage at Institute of Planetary Research
- http://lasp.colorado.edu/cassini/ Project homepage at Laboratory for atmospheric and space physics

Instruments/Experiments:

- **MIMI** Magnetospheric Imaging Instrument; A neutral and charged particle detection system
- **UVIS** Ultraviolet Imaging Spectrograph; Measuring instrument for Ultraviolet light in the Saturnian system
- **MAG** Dual Technique Magnetometer; Highly sensitive Magnetometer, absolute accuracy $\approx 1\ nT$
- **CAPS** Cassini Plasma Spectrometer; ion mass, ion beam, electron spectrometer
- **RPWS** Radio and Plasma Wave Science; Measuring instrument for electromagnetic emissions up to 16 MHz

Ulysses

Summary:

ESA/NASA Mission to explore the heliosphere of the Sun over all heliospheric latitudes; Properties of solar wind, heliospheric magnetic field, plasma waves and solar radio bursts

Ressources:

- http://www.mps.mpg.de/de/projekte/ulysses/
  Project homepage at MPS
- http://ulysses.jpl.nasa.gov/ NASA JPL homepage
- http://www3.imperial.ac.uk/spat/research/missions/space_missions/ulysses/
  Project homepage at Imperial College

Ressources (contd.):

- http://helio.estec.esa.nl/Ulysses/
  Ulysses archive by ESA
- http://nssdc.gsfc.nasa.gov/database/MasterCatalog?sc=1990-090B
  Ulysses Mission at National Space Science Data Center
- http://urap.gsfc.nasa.gov/
  Ulysses URAP Ressources by NASA

Instruments/Experiments:

- **EPAC** Energetic Particles Composition Instrument; Measuring flux, anisotropy and chemical compositon of energetic particles
- **SWICS** Solar Wind Ion Composition Spectrometer; Analyses solar wind particles
- **MAG** Dual Technique Magnetometer; Highly sensitive Magnetometer, absolute accuracy $\approx 1\ nT$
- **URAP** Unified Radio and Plasma Wave Experiment; electric field measurements up to 1 MHz and magnetic field measurements up to 450 Hz

Galileo

Summary:

ESA/NASA Mission to investigate the Jovian system and the Galilean satellites; Informations on surface/atmospheric composition, strength of magnetic fields; Masses and internal structures of the moons

Ressources:

- http://www.mps.mpg.de/de/projekte/galileo/ Project homepage at MPS
- http://galileo.jpl.nasa.gov/ NASA JPL homepage
- http://www-pw.physics.uiowa.edu/galileo/ University of Iowa linklist

Ressources (contd.):

- http://nssdc.gsfc.nasa.gov/planetary/galileo.html Galileo Mission at National Space Data Center

Instruments/Experiments:

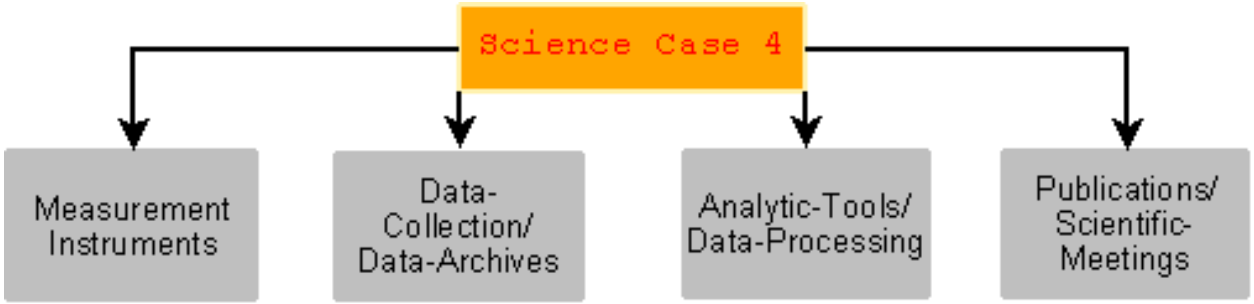
- **EPD** Energetic Particles Detector; Measuring the characteristics of energetic particles populations
- **MAG** Dual Technique Magnetometer; Highly sensitive Magnetometer, absolute accuracy $\approx 1\ nT$
- **PWS** Plasma Wave Subsystem; Measuring instrument for plasma waves and radio emissions

other Missions

- **Stereo:** Investigation of Sun's CMEs (Coronal Mass Ejections)
- **Wind:** Measurements on Radio and Plasma Waves emitted by Earth and Sun
- **Cluster:** Investigation of Earth's plasma environment; Interaction between solar wind and magnetospheric plasma
- **Doublestar:** Similar to Cluster; Researching the effects of the Sun on the Earth's environment
- **Interball 1 and 2:** Study of the physical mechanisms which are responsible for the transmission of solar wind energy to the magnetosphere.
- Other ground-based and Earth-orbit based observations (i.e. Hubble or specific radio telescopes)

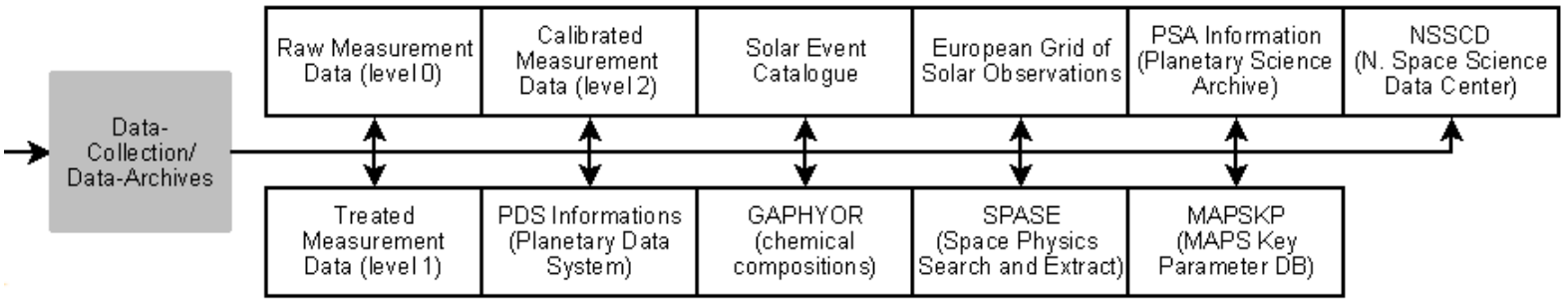
Outlook

Science Case 4 devided into four main-nodes of information:



1. *Measurement-Instruments:* including all instruments used at specific missions (mentioned above)
2. *Data-Collection/Data-Archives:* measurement data, but also all kinds of databases
3. *Analytic-Tools/Data-Processing:* software-tools and scientific routines to process measured data
4. *Publications/Scientific Meetings:* all related publications and reports; all important meetings

Data-Collection/Data-Archives



Summary:

- Raw, treated and calibrated data (part of RPWS)
- PDS (Planetary Data System); Scientific data from planetary missions, astronomical observations and laboratory measurements; http://pds.nasa.gov/
- SEC (Solar Event Catalogue); http://sec.ts.astro.it/

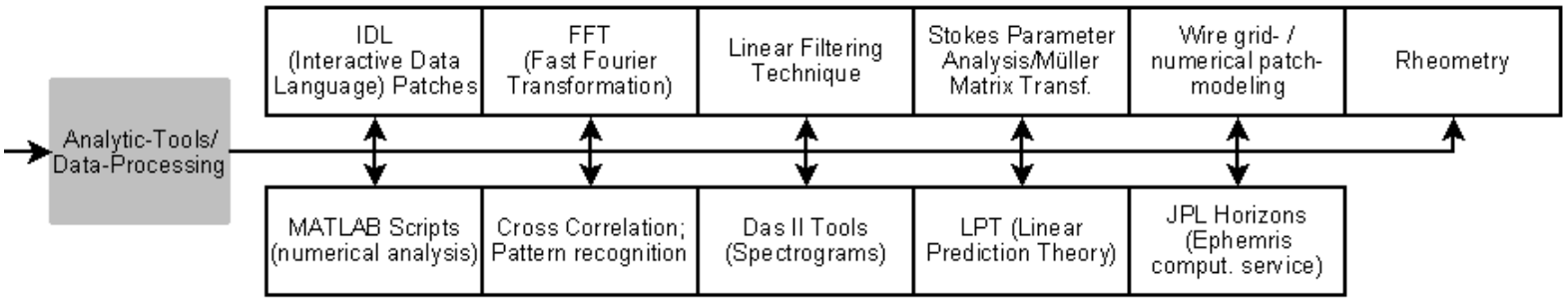
Summary (contd.):

- GAPHYOR; Database on the properties of atoms, molecules, gases and plasmas (including chem. reactions); http://gaphyor.lpgp.u-psud.fr/
- EGSO (European Grid of Solar Observations); Federation of solar data archives; http://www.egso.org/
- SPASE (Space Physics Archive Search and Extract); Space and Solar Physics Data platform; http://www.spase-group.org/

Summary (contd.):

- PSA (Planetary Science Archive); similar to PDS but hosted by ESA; http://www.rssd.esa.int/PSA
- MAPSKP (Maps Key Parameter Database); Key parameter data collection from the MAPS (Magnetosphere and Plasma Science) Experiment on Cassini; http://mapskp.cesr.fr/
- NSSDC (National Space Science Data Center); Data collection of astronomy and astrophysics, solar and space plasma physics, planetary and lunar science; http://nssdc.gsfc.nasa.gov/

Analytic-Tools/Data-Processing



Summary:

Software-Solutions:

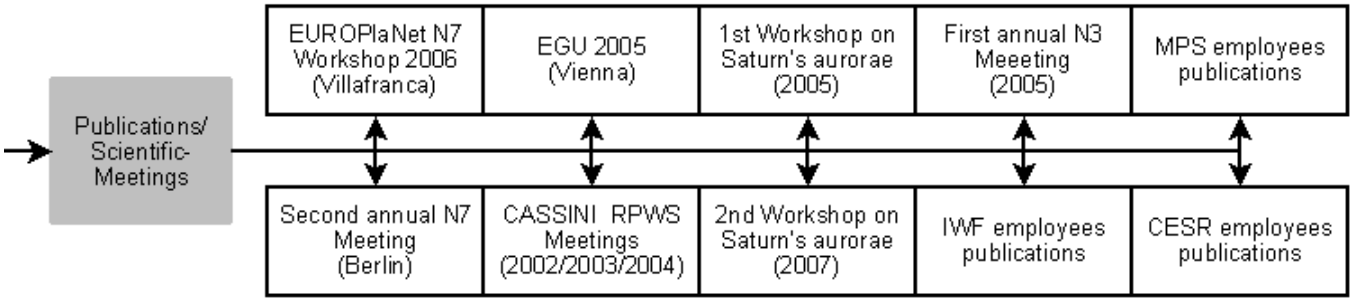
- IDL (Interactive Data Language) patches
- MATLAB scripts (numerical analysis)
- DAS II Tool (Spectograms)
- JPL Horizons (Ephemeris computation service)

Summary (contd.):

Routines/Techniques:

- FFT (Fast Fourier Transformation)
- Cross Correlation/Pattern Recognition
- Linear Filtering Technique
- Stokes parameter analysis
- Mueller matrix transformation
- Wire grid modelling
- numerical patch modelling
- Rheometry
- LPT (Linear Prediction Theory)

Publications/Scientific Meetings



Summary:

- EUROPlaNet N7 Workshop 2006 (Villafranca); Preliminary discussions on Science Cases; first proposals
- Second annual N7 Meeting 2006 (Berlin); further meeting/discussion on IDIS requirements
- First Annual Meeting N3 (2005)

Summary: (contd.):

- 1st Workshop on Saturn's aurorae 2005 (Graz); magnetospheric generation and energy considerations
- 2nd Workshop on Saturn's aurorae 2006 (Graz); comparative planetary aurorae
- 1st Workshop on ionosphere-magnetosphere coupling 2006 (Graz); fast flows/flux ropes in the Earth's magnetotail
- 1st Workshop on coordinated observations of Jupiter and Saturn during the New Horizons Jupiter flyby 2006 (Liège)
- CASSINI RPWS-Team Meetings(2002/2003/2004)
- IWF, MPS, CESR, MSSL, Imperial College employees publications
- ...

Organization-Chart

- Classification and collection of information is far from being complete
- Only IWF, MPS and partly CESR, MSSL and Imperial College where mentioned at the moment
- Additions specially at the data-collection and data-processing nodes have to be done
- Systems like the publications-database at MPS have to be integrated to simplify the process of contribution
- The classification of this science case must fit the needs of all contributers and users
- Connections between the single nodes, i.e. instruments & data-collections, would be beneficial

Questionnaire

- Which persons should be contacted to help finishing the organization-chart of this science case?
- How will the contribution-process be organised, how can we „tag“ our specific information with meta data?
- How can we help the scientists to keep the system up-to-date?
- Can we define all possible file-formats for this science case?
- Which other data-systems/data-bases can also be mentioned regarding this science case?
- What about future missions fitting this topic?
- How can we separate data which can be served public to restricted data?

Thank you for listening!

Notes, further suggestions, even corrections are most welcome!