Space Research, Astronomy, and Physics of the Atmosphere

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The three organizational entities of the Austrian Academy of Sciences described in this article represent areas of science that exhibit particularly rapid progress. Because of this situation, we have to keep in mind that several parts of the previous research plans have been overtaken by reality at the end of the 1996–2000 period. This can be due to the early completion of a project, where development in certain areas was more rapid than anticipated. Project goals and emphasis on certain topics may have changed significantly. Space-based projects, such as satellite missions in the framework of large international joint enterprises, may also not be executed as planned, in spite of excellent preparations. They may either be cancelled, their scope may alter due to changes in plans, or they may be postponed into the distant future – if they do not fail altogether. All this has to be taken into account for this research program for the 2001–2005 period, as the schedules for the later years may not be adhered to so strictly as at the beginning of this period. However, the underlying priorities and general directions are clear.

Space Research Institute

As in the previous reporting period, the Space Research Institute consists of three departments, specifically the Department for Experimental Space Research, the Department for Near-Earth Space Physics, and the Department for Satellite Geodesy. Following positive evaluation in 1997, the institute moved into a new modern building (AAS Research Center Graz) in November 2000, and began work on the upcoming projects under the direction of new departmental heads.

Department for Experimental Space Research

The main goals of the Department for Experimental Space Research are experimental, theoretical and applied space research, with special emphasis on space plasma physics. A particularly important aspect is the experimental determination and theoretical analysis of the interaction of the Sun, or more specifically the solar wind, with the bodies of the solar system, ranging from Earth (Cluster, CHIMAG) to other planets (Mercury: BepiColombo, Mars: NETLANDER) and icy bodies or comets (Rosetta).

The instruments developed for this purpose may also probe other areas, for example the interaction between satellites and the surrounding plasma (Cluster), space weather phenomena that affect the operation of navigation and communications systems in satellites (Cluster, CHIMAG), or magneto-telluric investigations of the global electric conductivity of the planets Mars and Mercury, and of Comet Wirtanen, as part of the missions NETLANDER, Bepi-Colombo and Rosetta. In addition, plans exist for studies of dust emission from Comet Wirtanen (Rosetta), of the propagation of electromagnetic waves and aerosols in the atmosphere of Saturn's moon Titan (Cassini/Huygens, in collaboration with the Department for Near-Earth Space Physics), and for the verification of predictions of the General Theory of Relativity by space experiments (in collaboration with the Department for Satellite Geodesy).

While the operational phases of several missions will be completed soon (Cassini/Huygens, CHIMAG) and those of others have just begun (Cluster), other satellites will only be launched in a few years (Rosetta, for instance, in 2003). The department will provide a number of new and improved instruments for these missions.

As part of its activities, the department maintains close contacts with NASA, ESA, and the Russian, German and French space agencies, as well as bilateral relations with China and Japan.

Department for Near-Earth Space Physics

The Department for Near-Earth Space Physics will continue a large portion of its research activities as part of long-term international programs. These include theoretical studies and analyses of radio emissions from Saturn as part of the current Cassini mission, as well as specific investigations into the receiver characteristics of the antennas of the Radio and Plasma Wave Science Experiment aboard the Cassini/Huygens spacecraft. In addition, complementary ground-based radio observations and corresponding analyses are carried out, as well as optimizations of measurement and analysis techniques in the general field of planetary and solar radio emissions. Theoretical models of the interaction of the solar wind with planetary magnetic fields are another core activity, particularly with regard to studies of Cluster data carried out in close collaboration with the Department for Experimental Space Physics.

The projects related to the INTERBALL mission (a Russian program to explore solar-terrestrial interactions) as well as a number of current INTAS

projects are limited in time, leading to a decrease in research activities for these areas.

Research priorities will be increasingly focused on participation in the ESA comet mission Rosetta, and on projects BepiColombo, Solar Orbiter and Mars NETLANDER. Topics relating to the latter include the investigation of extraterrestrial surfaces, the development of instruments to determine thermo-mechanical characteristics under space conditions, and statements on glaciological processes on Earth and on Mars. These priorities also lead to a more focused concentration on research topics that include the physics of the extraterrestrial environment: lightning strikes on Titan and Saturn, Io-Jupiter interactions, development of a new radio receiver for decameter waves, and investigations of antenna characteristics for the Solar Orbiter.

The department maintains intensive cooperation with NASA, a number of universities in the United States, with the European Space Agency, with several European institutes in the field of extraterrestrial physics, as well as with institutions of the academies of sciences in eastern Europe. Specific cooperative projects exist in research projects that unite western and eastern nations, such as INTAS projects with France, Belgium, and the United Kingdom, as well as Russia, Ukraine, Poland, and Hungary.

Department for Satellite Geodesy

The Department for Satellite Geodesy contains three research teams for the measurement of the Earth's gravitational field, for laser metrology, and for GPS geodynamics respectively. While current projects are being continued, the focus of activities during the next five years will be the collaboration with the ESA mission Gravity Field and Steady-State Ocean Circulation Experiment (GOCE). The launch is currently planned for 2005, making satellite altimetry a somewhat lesser priority. GOCE will determine the Earth's gravitational field with the highest accuracy, providing an extremely important contribution to geodesy, oceanography, and the physics of the Earth's interior.

The accuracy of the laser ranging station in Graz has increased: measurements of satellite distances with a precision of three millimeters are now possible, bringing the determination of minute effects within reach. Similarly, a network of permanent GPS stations, covering all of Austria, together with the European base stations, allow the precise observation of coordinate changes and of parameters of the troposphere. In turn, this leads to an improved determination of global and regional crust movements, and to answers to meteorological questions.

A number of renowned universities and research organizations are contributing to these projects, including the technical universities in Graz, Munich, and Delft, the universities of Bonn, Copenhagen, Milan, and Berne, the Politecnico di Milano, Alenio Aerospazio, CNES, the Geo-Research Center Potsdam, and the European Space Agency.

Overall, the Institute for Space Research plans to concentrate its schedule of research topics and to intensify collaboration between individual departments. This should lead to increased efficiency and synergism that is further promoted by the excellent working conditions at the new center.

Commission for Astronomy

The Commission for Astronomy (CfA) serves primarily as the point of contact to the International Astronomical Union. It also continues to cover several niche areas of astronomical research in Austria with small projects, as it has done for several years now. Since the Commission operates without directly funded personnel and without dedicated office space, it has to rely on voluntary contributors.

The CfA mainly supports solar research in the form of projects that are carried out at the Kanzelhöhe Solar Observatory of the University of Graz on Mt Gerlitzen in Carinthia. The planned activities for the last reporting period have been largely completed. Data acquisition has been transferred from film to electronic detectors (CCDs), and the data sets are now available via the Internet. In addition, the valuable archive of photographic sunspot data covering the last fifty years has been scanned and can now be retrieved electronically as well. The justification for maintaining this endeavor lies in the continually changing, non-repeating nature of the Sun's activity over each solar cycle, and in the increasingly close connection with solar exploration from space.

The main goal of the Commission's interactions with the newly created Institute for Geophysics, Astrophysics and Meteorology (IGAM) of the University of Graz can be described by the terms space weather modeling and forecasting. This activity requires a global observing strategy using different wavelength ranges and parameters (visible light, infrared, magnetic fields, and space-based observations), ultimately leading to more precise predictions for solar-terrestrial interactions. The Academy furthers international cooperation through exchange programs with partners in China, Croatia, the Czech Republic, Egypt, Germany, Hungary, Italy, Slovakia, Spain, Switzerland, Ukraine, the United States, and last but not least the European Space Agency.

The CfA also promotes studies of the large and small-scale dynamics of the solar surface and of the Sun's deeper layers. These research activities will certainly lead to the establishment of a better understanding of the interactions between Sun, Earth and interplanetary space (see also the section on the Institute for Space Research), and ultimately to insights into their influence on meteorological phenomena and terrestrial life.

Research activities on minor planets have ended during the previous reporting period. The Com-

mission is now engaged in research on the history of astronomy, and has issued a database of Austrian astronomers. This is to be supplemented in the near future by a multi-media database on past and present Austrian observatories.

Commission for Clean Air

Since its inception, the Commission for Clean Air (CCA) has dealt with all areas of anthropogenic air pollution, both from the global and specifically Austrian point of view. It also advises government entities on environmental questions. Long-term projects concentrate on the most relevant topics. These include the establishment of criteria for clean air and of limits for pollutants. The Commission also monitors international developments and maintains contacts with international research and advisory institutions.

The interdisciplinary Austrian Project on Health Effects of Particulates (AUPHEP) continues to be of high priority. This project was started in 1998 and is planned to cover a four-year period. It explores the general health-related effects of small particles (of the order of one micron or smaller), and the situation in Austria in particular. The CCA also explores the increasing concentration of carbon dioxide in the atmosphere and potential effects on Austria, such as climate changes.

The CCA's mission includes the dissemination of general environmental information through discussions and presentations. It also plans to document the history of environmental issues in Austria since 1945.