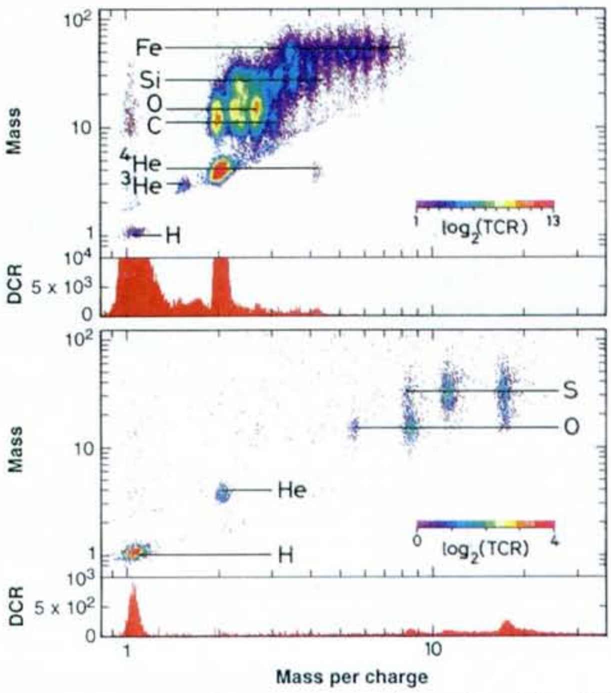
JOVIAN ATMOSPHERE

Ions from the Satellite Io Dominate



The mass versus mass/charge matrices of the solar wind well after the encounter (upper) and of the Jupiter magnetosphere (lower). The triple coincidence rates (TCR) are colour coded in the upper parts of the panels while the double coincidence rates (DCR), for which mass information is unavailable, are given in histograms below.
The two ion populations differ in two important respects: elemental abundances and charge states, the former owing to the dominating contribution of Io material in the Jovian magnetosphere (there are larger amounts of S and O ions). The q/M data indicates that solar wind ions are nearly equilibrated in the ≈10^7 K environment of the low corona.

The Solar Wind Ion Composition Spectrometer (SWICS) aboard Ulysses allows the determination of the mass loading of the rotating magnetic field of Jupiter, which in turn determines the effect of centrifugal forces on the geometry and dynamics of the Jovian atmosphere. SWICS combines energy-per-charge separation by an electrostatic analyser (0.6 to 60 keV/e), acceleration (23 kV), time-of-flight (tof) measurement, and determination of total energy with solid-state detectors. For an ion producing a triple coincidence (two tof and one solid-state detector signals), this technique allows the determination of ion mass M and charge q separately so that different ion species can be distinguished even if they have equal M/q ratios. A double coincidence (tof only) permits only measurement of M/q. The coincidence methods used suppress background, an important feature in the strong radiation fields of the Jovian magnetosphere.

SWICS measured for the first time the composition of the main plasma in the magnetosphere at very different distances from Jupiter and at different latitudes. We found everywhere a strong contribution of ions for Io, and that some solar wind ions penetrated deep into the magnetosphere. We were even able to identify unambiguously ions from Jupiter's atmosphere far away from the planet.

Io is an exceptional body in our Solar System. It is similar in size to the Moon and thus, like the Moon, too small to produce (4.5 Gy after its formation) an endogenous volcanism. Io's strong volcanism bringing relatively volatile material (including O and S) to the surface results instead from a kneading caused by Jupiter's tidal forces. This material overcomes the gravitational attraction of Io, probably with the help of electromagnetic forces, and escapes into the magnetosphere and eventually leaves Jupiter's sphere of influence. Io ions dominate the mass density of the Jovian atmosphere and cause the ion composition to be exceptional.

Previous spacecraft had found that much of the Jovian atmosphere was rich in O and S ions from Io. The new findings extended measurements to other regions, thus placing more severe constraints on models of plasma circulation, radial transport, and loss from the magnetosphere, with the identification of ion masses needed for proper assessment of terms in mass-balance equations.

The SWIC's experiment involves groups from Bern University, TU Braunschweig, MPI für Aeronomie, University of Maryland (USA), and NASA's Goddard Flight Center. European participation in all Ulysses experiments is conceived, managed and implemented by institutes and universities with national funding.

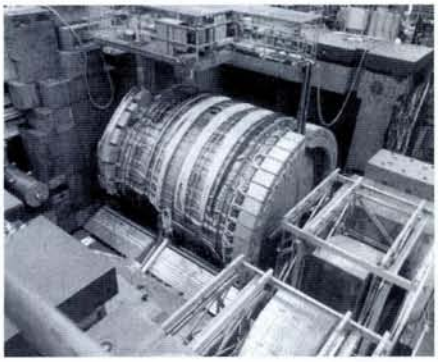
J. Geiss, *Bern University*

HERA Enters Second Phase of Data Taking

DESY in Hamburg collided electron and proton bunches for the first time a year ago in its new HERA storage ring complex. Machine studies then concentrated on the lifetime of the proton beam and the first examination of the transverse polarization of the electrons. There followed a nearly four-month shutdown to move the two large experiments H1 and ZEUS into position. A major concern of high-energy ep colliders, of which HERA is the first and probably the only one for many years to come, is that the proton beam would be sensitive to excitations caused by the opposing electron beam because it does not experience synchrotron radiation damping. These effects turned out to be sufficiently weak, provided the beam sizes at the interaction point are well-match and the proton betatron tuning is optimised.

So the run-up to the 820 GeV proton design energy was tackled with confidence starting in April; protons were stored at this energy for the first time in May 1992. The electron energy has been kept slightly below the 30 GeV design value to continue earlier work on polarization and stability. Data taking with collisions of single electron and proton bunches first occurred on May 31 and continuous experimental operation began about a month later. Operation until early in August gave 20% availability to experiments using 10 stored bunches in both rings, but with 20% of the design level for the proton bunch intensity pending more work on the proton pre-accelerators. A drastic reduction of the electron beam's lifetime at higher beam currents was observed on attempting to increase the luminosity by increasing the numbers of electron and proton bunches. The origin of this effect is not yet fully understood. The luminosity for the 10-bunch mode normalised to the beam intensity has reached the design value so in this crucial respect, HERA performs to expectations.

A second phase of data taking started in September and runs until November. The machine's availability is already rising and peak luminosity is expected to be increased by increasing the number of bunches. Wulfrim Bartel of DESY says the first physics results mainly address three topics. The total cross-section for photon production has been measured in a hitherto unexplored energy range (230 GeV in the centre of mass). It is rising, but not as steeply as some models predict. Regarding the structure of the photon: strong indications for so-called resolved photon processes reflecting quark structure have been observed for the first time. Thirdly, for deep inelastic scattering, HERA studies the structure of the proton at high momentum transfers (Q^2) and at values of x, the proportion of the momentum of the proton carried by the quark, some 10^2 times smaller than for previous experiments. H1 and ZEUS have also looked for exotic particles like leptoquarks and excited electrons, but for this type of research more data is clearly required.



HERA's H1 detector being moved into position. Both H1 and Zeus, the other HERA detector, are now being used routinely.