Pulsation of 51 Pegasi would be accompanied by luminosity and colour variations as well as by phase-related absorption line asymmetries. However, all-sky surveys carried out by the HIPPARCOS satellite indicate that stars with spectral features similar to those of 51 Pegasi are among the most stable. Moreover, no mechanisms have been identified which are able to excite pulsation modes as long as four days in solar-type stars. For instance, only very low amplitude (<< 1 m/s) modes and periods of minutes to one hour are detected for the Sun. Radial velocity variations of a few days and less have been observed for a few giant stars larger than 20 solar radii in size. However, 51 Pegasi is certainly not this large. Nor does it show short-period simultaneous pulsations that are characteristic of giant stars.

Photometric measurements of 51 Pegasi and of two companion stars carried out earlier this year do not completely rule out the possibility of a very low pulsation. Although stronger constraints stemming from HIPPARCOS data are expected shortly, it is noted in the meantime that pulsations are known to affect the symmetry of absorption lines. Such a feature has been sought for without success using the cross-correlation technique. So an interpretation of the observed velocity variations as being due to the orbital motion of a very low mass companion planet seems to be the most convincing.

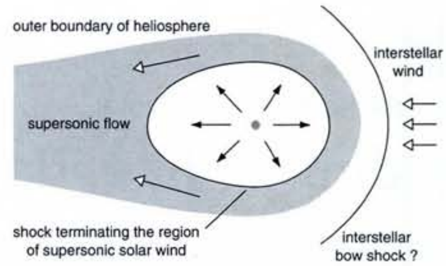
Exciting Perspectives

It is clear that the mass and orbital eccentricity of the 51 Peg B companion are similar to those for heavy planets. But this does not mean that the companion forms in the same way as Jupiter. Most importantly, present models do not predict the formation of Jupiter-like planets with separations as small as 0.05 AU (well within Mercury's orbit in our Solar System). It is unlikely that the accumulation of ice grains to give a Jupiter-like planet followed by orbital decay due to dynamic effects would result in a orbit as small as 0.05 AU. Secondly, all of the planets in the Solar System which are heavier than 10^{-6} solar mass have circular orbits since they grew from a protoplanetary gaseous disc. The low eccentricity of 51 Peg B does not represent evidence for a similar effect since the separation is very small. Instead, dynamical evolution of the system rather than the formation conditions may be responsible for the low eccentricity. One possibility is that 51 Peg B resulted from the radiative stripping of a nearby brown dwarf of low mass. If this is the case, it would be mostly made up of heavy elements.

Notwithstanding these more general issues, it is the possible presence of a second long-period companion to 51 Pegasi that is of the most immediate interest. If it also turns to be in the Jupiter range with a nearly circular orbit, the Geneva team will have discovered the first example of an extrasolar planetary system associated with a solar-type star.

[1] Wolszczan A., Frial, D.A., *Nature* **355** (1992) 145; Wolszczan A., *Science* **264** (1994) 538.
[2] Mayor M., Queloz, D., *Nature* **378** (1995) 355.

The Heliosphere and its Neighbourhhod



The general characteristics of the heliosphere (W. I. Axford, 1992).

The Sun's immediate neighbourhood — the heliosphere — is dominated by the solar magnetic field and the solar wind. How it is embedded in the local interstellar medium (LISM), and how these two fundamentally different media interact with each other are of fundamental importance. A dozen space missions are presently making observations both inside the heliosphere by *in situ* measurements (*e.g.*, Ulysses, exploring its three-dimensional structure, and the Voyager and Pioneer spacecraft in the outermost regions) and outside the LISM in all wavelength bands (*e.g.*, optical observations from the Hubble Space Telescope, and ultra-violet and X-ray measurements from EUVE and Rosat, respectively).

The main task of the workshop *The Heliosphere in the Local Interstellar Medium* (Bern; 6-9 November 1995) with over 40 participants from 9 countries on 3 continents — the first event to be held at the new International Space Science Institute (see insert) — was to bring together representatives of these two approaches, as well as theorists and modellers of the heliosphere, in an enviroment which would stimulate the exchange of views and data. The aim was to reach agreement on the principal parameters (such as the size of the heliosphere and the density and temperature of the LISM) and to identify points of disagreement and ways to overcome them.

Excellent agreement was reached regarding the direction and speed at which the heliosphere moves through the local cloud, as obtained from *in situ* observations of interstellar neutral gas on Ulysses and from Hubble observations of interstellar absorption lines in the spectra of bright stars. However, is now clear that accurate values can only be obtained by monitoring helium because other constituents of the LISM (in particular, hydrogen and oxygen) are affected either by deceleration and pile-up upstream of the heliopause or by deflection in front of this boundary.

Observations of interstellar hydrogen absorption lines and of the backscatter of solar Lyman-α radiation from the LISM reveal that our local cloud, which is about 1 parsec (3 x 10^{13} km) in size, may not be the home of the heliosphere much longer. Absorption spectra clearly show a second component moving at a somewhat higher speed, caused by the neighbouring G-cloud (located towards the galactic centre), into which we will move sometime during the next millennia.

The composition of the gas in our local cloud can, in principle, be determined from *in situ* observations of interstellar pick-up ions in the solar wind. However, it became apparent at the workshop that the interpretation of data needs a better understanding of ionization rates and of ion transport in the interplanetary medium. Nonetheless, the pick-up measurements confirm the view that these ions form the seed population of the anomalous cosmic-ray component, whose most prominent feature is the virtual absence of carbon. In line with this view, the recently discovered, and quite unexpected, pick-up carbon ions could be shown to stem from a local source inside the heliosphere (their three-dimensional distribution indicates that evaporating interstellar grains are the source).

The distance to the termination shock R_t where the solar wind passes from the supersonic to the subsonic regime, and to the heliopause R_h where the solar wind meets the interstellar gas, has been addressed by several different methods. Perhaps the clearest indication of R_h comes from two major radio events observed by Voyager, placing it at a distance of 110-160 astronomical units (AU). Theoretical modelling indicates $R_t = 2/3\, R_h$, putting the termination shock well within reach of the Voyager spacecraft, currently at over 60 AU and moving outward at nearly 4 AU per year. A poll among the participants resulted in a value of $R_t = 87 \pm 5$ AU, which means that Voyager ought to reach the boundary of our heliosphere within the next decade. The result may, however, be biased to a low value owing to the participants' hope that they will be alive to witness this historic event.

International Space Science Institute

The International Space Science Institute (ISSI) was formally inaugurated on November 10, several months after opening its doors to collaborators. Modelled on advanced studies institutes, the ISSI aims to enable space scientists involved in today's many space missions to pool data and understanding in order to interpret scientific results in a broad, interdisciplinary context while not overlooking the results of ground- and laboratory-based research. J. Geiss, the ISSI Executive Director and a prime instigator behind the initiative, thinks that the new institute will be able to "bring out an integrating view" to studies that encompass many aspects. This approach clearly struck home to delegations to the Inter-Agency Consultative Group (IACG) from the European Space Agency (ESA), NASA, Japan's Institute of Space and Astronautical Studies (ISAS), and the Russian Academy of Sciences when the IACG endorsed the ISSI's scope in 1994. In the 1980's, these national agencies mandated the IACG to coordinate missions to Halley's Comet and programmes in solar-terrestrial physics because

J. Geiss, the ISSI Executive Director (on the right) and R. von Steiger.

international space activities needed better integration.

The ISSI essentially reinforces international and multidisciplinary aspects by complementing major national and university institutes catering for space science. It also provides Switzerland, a significant ESA contributor, with an institution of international standing on which to focus activities and public awareness. Consequently, ESA, the Swiss federal government, Swiss industry, and local authorities support the Institute. The foreseen budget ceiling is some 2 MECU covering a permanent staff of 12-15, temporary support for visiting scientists at all stages in their careers and facilities close to the Bern University's science faculties.

The ISSI will concentrate initially on solar-system sciences where the need for an interdisciplinary institute was vividly demonstrated by the first ISSI Workshop (see above) at which significant progress was made in tackling major outstanding issues concerning evidence for a weak, as opposed to strong, shock at the heliopause and the concentration of hydrogen in the heliosphere. Hydrogen is the main constituent so it is largely responsible for the heliosphere's pressure and hence the heliosphere's interaction with the interstellar medium.

ISSI's integrating activities focus on so-called Principle Investigator (PI)-type missions where a locally financed team led by a PI is responsible for the construction, operation and output of an instrument aboard a spacecraft. At the other extreme one has observer-type missions where an agency operates a space facility on behalf of users. PIs and their teams naturally enjoy certain benefits such as the right to first discovery, privileged use of data for two years, *etc.* The ISSI will not jeopardise these privileges but instead bring teams together across missions in such areas as the Sun-Earth relationship, heliosphere and cometary research, and the physics of solar and space plasma, where there are links to astrophysics, astronomy and earth observation.

Professor Geiss feels that it is too early to even guess at the ISSI's future interests since the IACG has yet decide its future orientation and role. The International Solar-Terrestrial Programme (IASTP) is expected to run for at least a decade, by which time it should be clear if the ISSI will turn more towards astronomy or towards planetary research, notably lunar and Earth-oriented aspects.

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HIGH-ENERGY PHYSICS

Seeking a Comprehensive Understanding

P.M. Zerwas from DESY, Hamburg, reports on the latest results presented at the *1995 International Europhysics Conference on High-Energy Physics* (Brussels, 27 July – 2 August 1995).

High-energy physics is presently split into two streams namely, the ever increasing experimental evidence supporting the Standard Model, and preparations for experiments at the TeV-energy scale, where the model is expected to be embedded in a more comprehensive theory. This duality was truly reflected in talks at the *1995 International Europhysics Conference on High-Energy Physics,* which provided an excellent overview of new results in particle physics.

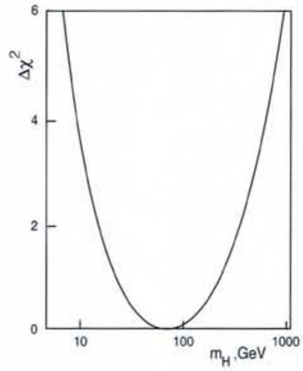
The Standard Model

The Standard Model (SM) of particle physics consists of "matter particles", "forces" and the "Higgs mechanism".

• **Matter particles**. Leptons and quarks organize themselves into three families of identical structure. Each family consists of a pair of neutrinos and charged leptons, and a pair of charge +2/3 and −1/3 quarks. These particles are pointlike at the present scale of experimental resolution. In fact, DESY's HERA and CERN's LEP have set upper limits of less than 10^{-17} cm on the radii of these particles. The heaviest of the quarks, the top quark, has recently been discovered at the Tevatron in the USA (A. Menzione) with a mass $m_t = 176 \pm 11$ GeV which corresponds approximately to the mass of the gold atom.

Although the top quark was proven to exist as the isospin partner of the b quark a long time ago, the successful prediction of the top mass from electroweak data is one of the triumphs of high-precision experimentation in particle physics and quantum field theory (W. Hollik). Since the number of (nearly massless) neutrinos has been determined to be three in invisible Z-decays, the ensemble of matter particles with the texture of the SM is now complete.

Whether **charge-parity** (CP) violation is realised in Nature through a complex mixing between quarks of different families is one of the SM's outstanding problems. While all observed phenomena in the K-$\bar{K}$ complex are compatible with this hypothesis, the *experimentum crucis* will be the observation of CP-violation in the B-$\bar{B}$ complex (R. Aleksan). This problem can be tackled by observing the difference of the time evolution of B and $\bar{B}$ beams in the $J/\psi K_S$-decay mode. Two asymmetric e^+e^- colliders will be built (at SLAC in the USA and at KEK in Japan) to solve the problem. They are in a race, however, with HERA-B, a dedicated experiment at DESY in which the HERA proton beam will collide with a fixed nuclear target to produce B/$\bar{B}$ mesons (experiments begin in 1998/9).



The mass of the Higgs particle as estimated using today's data. A fairly small Higgs mass of order 70 GeV is preferred, with a large error, however, stretching the mass range up to 600 GeV.

• **Forces** are built-up in the SM by the exchange of gauge particles associated with a SU(2) x U(1) symmetry in the electroweak sector, and with a SU(3) symmetry in the strong sector. Many properties of the gauge particles in the electroweak sector, the photon and the W^{+-}/Z bosons, are already known very accurately, notably masses, lifetimes and couplings to leptons and quarks (A. Olchevski, G. Rahal-Callot, S. Komamiya, J.M. Gerard).

LEP has determined the mass of the Z boson with unprecedented precision ($M_Z = 91188.4 \pm 2.2$ MeV). The measurement of the W boson mass is steadily improving. A new quality will be reached shortly at CERN's upgraded LEP2 collider (collisions, at 130 GeV, were observed for the first time on 31 October) where the residual error will presumably be reduced to less than 30 MeV. The non-ablian symmetries predict the form of the self-interactions of the gauge bosons, or equivalently, the magnetic dipole moments and the electric quadrupole moments of the gauge particles. Present experiments at the Tevatron only slightly constrain these static electroweak parameters. LEP2 will improve the situation significantly by restricting anomalous components to less than about 0.2. CERN's LHC $p\bar{p}$ collider will be needed and, even better, future e^+e^- linear colliders, to perform high-precision tests of the non-ablian symmetries in the electroweak sector at a ≤ 0.01 level.

Quantum chromodynamics (QCD) is the microscopic theory of the strong interactions. It is based on quarks and gluons which have been established in the 1970s by the observation of three-jet events at DESY's PETRA storage ring. After isolating the gluon self-couplings in the four-jet distribution of hadronic Z decays at LEP, the main problem which remains to be solved in QCD is the high-precision determination of the **QCD coupling** and unambiguous evidence for asymptotic freedom which makes the strong coupling weak at high energies. Presently, the experimental values extracted from hadronic