between the K-edges of carbon and oxygen) as this permits the study of living matter in its natural environment, the holy grail of many biologists. A demanding application is connected with the heavy-ion fusion scheme proposed by C. Rubbia [3] in which 3 MW of (peak) power, at a wavelength of 84 nm, will be needed for photo-ionizing Bi^+ ions.

Microwave FELS

There are also important applications for the FEL in the microwave region at the other end of the electromagnetic spectrum. The first is in high-energy physics, where the FEL is a candidate for a radiofrequency source for the next generation of colliders. This application is related to the need for much higher frequencies (needed to keep the accelerator dimensions within reasonable limits) than those which can be obtained using klystrons. The second application is in thermonuclear fusion. In future reactors such as the international fusion test reactor ITER now being designed, high-power microwaves will be absorbed locally to tailor the current-density profile. Even for the least demanding applications, several MW of power at frequencies ranging up to 300 GHz will be needed. These requirements might be difficult to meet using the radiofrequency sources used at present, the so-called gyrotrons. Furthermore, gyrotrons are essentially non-tunable whereas rapid tunability will be of vital importance for suppressing plasma disruptions involving the essentially instantaneous deposition of the entire plasma energy onto the walls of the reactor that are usually initiated by a local instability. Rapid adjustment of the microwave frequency can be used to locally manipulate the plasma, with the aim of suppressing a growing instability before it evolves into an overall disruption. An induction linac-driven FEL carried out a short series of pilot-scale plasma heating experiments at the MTX tokamak at the Lawrence Livermore National Laboratory in the USA before the work using this approach was discontinued.

Research groups around the world have operated FELs in the microwave range in the past. The required beam energy is typically one to several MeV; the usual approach is to work at a beam current which is high enough to achieve saturation of the laser field in a single pass through the undulator so that there is no need for an optical cavity. Consequently, a compact accelerator with a pulse duration of typically 100 ns (such as a Marx generator) can be used. However, this duration is too short for the applications mentioned above, particularly those in nuclear fusion, where a continuous laser output is required. A free electron maser designed to produce 1 MW of output power at 200 GHz has been under development at the FOM-Institute for Plasma Physics since 1991. Operation in the continuous mode and at high efficiency will be possible *via* recovery of the beam charge and energy downstream of the undulator (a similar scheme is used in the low-power, far-infrared FEL at Santa Barbara).

As regards applications in high-energy physics, a programme to develop microwave FELs started recently at SLAC in Stanford, USA, where one of the investigators is R.M. Phillips who invented the ubitron some 25 years ago.

[1] Phillips R.M., *Nucl. Instr. Meth. A* **272** (1988) 1.
[2] Dlott D.D. & Fayer M.D., *IEEE J. Quant. Elect.* **27** (1991) 2697.
[3] *Europhysics News* **23** (1992) 5.

The THEMIS Telescope

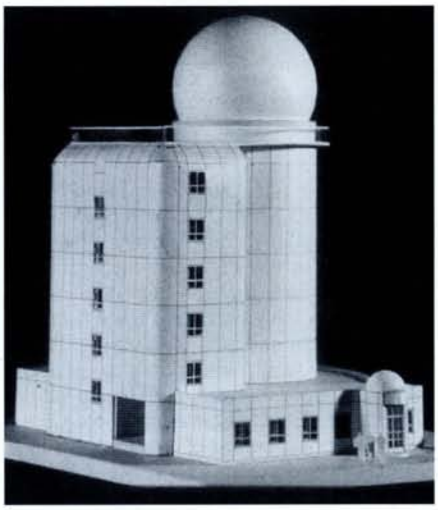
THEMIS is scheduled to be operational within three years. Its design will make it one of the most powerful instruments for the study of solar magnetism.

THEMIS is an acronym standing for *Télescope Héliographique pour l'Etude du Magnétisme et des Instabilités Solaires.* It started nearly 10 years ago as a uniquely French project, but approximately two years ago the Italian solar physics community joined the project with the signing of a formal agreement between the French *Centre National de la Recherche Scientifique* (CNRS) and the Italian *Consiglio Nazionale delle Ricerche* (CNR). The CNR is participating through a financial contribution, construction of a technologically sophisticated dome, and the implementation of post-focus instrumentation with a filter of high spectral resolution.

With a very high polarimetric accuracy, an excellent spatial resolution, and the possibility of observing simultaneously the Stokes parameter profiles of many spectral lines, it is expected that THEMIS will provide a breakthrough in the study of solar magnetism at very high spatial resolutions (< 0.3 arcsec). Accurate spectro-polarimetric observations will also be extremely important in studying the following related topics:

- energy transport mechanisms and velocity fields in magnetic structures;
- magneto-hydrodynamic turbulence and magneto-convection;
- the onset of instabilities, flares, and electric currents;
- fundamental processes in atomic physics (radiative transfer for polarized radiation, Hanle effect, impact polarization, *etc.*).

THEMIS is provided with an evacuated Cassegrain telescope with an azimuthal mount, and a Ritchey-Chrétien primary mirror of 90 cm in diameter. As the basic goal is the measurement of vector magnetic fields through the signatures observed in polarized radiation, normal-incidence optics is obviously necessary before the polarimetric analysis. Many modes of polarization analysis will be



A model of THEMIS.

possible by exchanging automatically the analyzer and the related optics.

The study of solar magnetism implies high spatial resolution. This is made possible by the selection of an appropriate site (Izaña, Tenerife), and by correction of image motion by means of a tilting mirror, activated using a granulation tracker at frequencies exceeding 100 Hz. The telescope will also be equipped for highly flexible spectroscopy to make possible the simultaneous observation of two Stokes parameters profiles in typically 10 spectral ranges, arbitrarily distributed along the spectrum (a long predisperser — with three exchangeable gratings — and an echelle-spectrograph will provide this unique possibility). Additive or subtractive modes will also be possible. Spectra will be recorded using several two-dimensional CCD cameras (288 x 384 pixels). Typically, one will be able to observe 10 spectral ranges in 2 polarization directions, at 384 wavelengths in 288 points along the slit (which implies 2.2×10^6 data readings!) every few seconds.

Several observing modes will be catered for. Besides the multi-line spectroscopy mode (probably the most important), it will also be possible to rapidly perform two-dimensional spectroscopy in the so-called MSDP (Multichannel Subtractive Double Pass) mode. Alternatively, the telescope is operated in the so-called magnetograph mode using a slit in subtractive spectroscopy. The longitudinal component of the magnetic field and the Doppler velocity can thus be deduced. This observing mode is very fast and will be a great advantage in coordinated observations between ground- and space-probes (*e.g.*, the SOHO satellite mission). Finally, the special Italian-designed filter that combines a tunable, universal birefringent filter with a tunable Fabry-Perot interferometer will allow two-dimensional spectroscopy.

Egidio Landi Degl'Innocenti
Dipartimento di Astronomia e
Scienza dello Spazio, Università di Firenze

ECAMP 5

The 5th European Conference on Atomic and Molecular Physics (ECAMP 5) will be held in Edinburgh, UK, on 3–7 April 1995. The Local Organizing Committee (Chair.: J.P. Connerade) and the International Programme Committee (Co-chairs: J.P. Connerade and H. Hotop) have been appointed, and on behalf of the Atomic and Molecular Physics Divsion, AMPD members are invited to make written suggestions for titles and speakers before **31 January 1994**. Most of the programme will be decided in April 1994, and the first circular mailed in May 1994. Correspondence should be sent to Dr. N.J. Mason, Secretary, ECAMP 5, Dept. of Physics & Astronomy, University College, Gower St., London WC1E 6BT, UK (tel./fax: +44-71-380 77 97 / 380 71 45; email: ucaps7n @ ucl.ac.uk).