A New Non-Linear Spectroscopy Facility

Nestling below the villa on the Arcetri hill overlooking Florence where Galileo spent the last years of his life is a new building (see photo) that provides a collection of quite remarkable beams. In some respects it is only the scale of the centre which differentiates it from a normal beam factory: for the beams are of laser light and the experiments conducted on table tops, albeit very carefully constructed.

The centre is the European Laboratory for Non-Linear Spectroscopy (LENS in Italian) established to provide state-of-the-art spectroscopic facilities to European researchers. Comprising four small laboratories specified according to the types of laser beams available (ultrafast, continuous wave, nanosecond and infrared), it responds to the need for a variety of facilities to exploit the vast range of opportunities opened up by the availability of pulsed and tunable high resolution laser sources.

These sources are used for non-linear and high resolution spectroscopy where new techniques can provide atomic and molecular information inaccessible by other methods. Indeed, LENS is one of the few facilities able to carry out a range of laser spectroscopies with high accuracy in both time and frequency, where costs are high and technical requirements stringent. Combining this with the means to produce supersonic streams of cold atoms and molecules with well defined characteristics provides exceptional possibilities.

Examples of recent results illustrate the precision which can be achieved. Fig. 1 indicates that the relaxation of the plastic phase of a polymer (sucinonitrile) occurs by a 13 ps rotation of the molecule, while Fig. 2 demonstrates that LENS's tunable far infrared spectrometer is able to resolve all of the rotational components of ozone in the sub-mm region (they are not resolved at high frequencies using conventional high resolution Fourier spectroscopy).

A Quick Start

The idea of a European spectroscopy laboratory called LENS was first mooted in 1987. A proposal for a scientific director was put forward in 1988 and in 1989 the Laboratory was established by the European Commission under the Technological Development Project of the Large-Scale Facilities Programme (see Europhysics News 22 (1991) 130). The laboratory was opened on 18 December 1991.

The new facility is housed in a two-storey building (LENS's main building). It consists of a laboratory area, offices, laboratories and offices, and common areas. The laboratory area is divided into four small laboratories, each with its own specific function.

Fig. 1 — The relaxation kinetics of the plastic phase of sucinonitrile measured by the sub-picosecond time resolved optical Kerr effect. Some polymers show a plastic phase characterized by the presence of translational order, as in real crystals, with orientational disorder. This disorder is dynamic and can be studied by light scattering in the frequency domain or directly in the time domain. The figure plots the transient optical Kerr effect intensity variation with time at 273 K for a typical decay and the inset represents the suggested mechanism for the slow (13 ps) component of the relaxation kinetics.

Fig. 2 — The pure rotational spectrum of ozone in the sub-mm range. a, upper) The spectrum taken with a high resolution (0.003 cm⁻¹) Fourier transform spectrometer. b, lower) A portion of the spectrum obtained with the tunable far-infrared spectrometer at LENS. (spectral coverage: 0.3-6 THz, instrumental linewidth and absolute accuracy: 50 Hz or > 10⁻⁷). All the components are resolved within the Doppler width.