1994 EGAS

Steady Progress and New Developments

The variety of topics presented at the 26th annual conference of the European Group for Atomic Spectroscopy (EGAS) demonstrated once again the great vitality of the field, which combines continuous progress on let us say classical problems with the development of new, exciting subjects. A field of intense activity involves **special atomic entities** such as negative ions, highly ionized atoms (or multi-charged ions), unstable or exotic atoms ($^{150}Eu^{+}$, muonium), and atoms or ions in superfluid helium. Two invited talks covered topics in these areas, with C. Blondel (Laboratoire Aimé-Cotton, Orsay) describing spectroscopic methods which are applied to negative ions as well as the measurements that can be made following the interaction of the ions with light. He also considered multiphoton absorption and detachment phenomena in these species. G. Huber (Mainz), in reporting on work carried out at a heavy-ion storage ring, discussed topics related to the cooling of ions and laser spectroscopy as well as the first results on the 1s hyperfine splitting of the "hydrogen-like bismuth" ($^{209}_{83}Bi^{82}_{4}$) ion which are relevant for testing QED and understanding nuclear magnetization. High-order QED corrections for multi-charged ions are in fact being studied by several groups.

Concerning **coherent and non-linear atomic phenomena**: Rydberg states of atoms (*i.e.*, bound states near the ionization threshold) as well as auto-ionizing states (*i.e.*, "bound" states above the ionization threshold) of atoms, negative ions and molecules attracted much interest. H.B. van Linden van den Heuvell and co-workers (Amsterdam) reported a novel technique for studying wave-packet dynamics based on excitation using two identical ultrashort laser pulses for which the relative phase difference is modulated. These wave-packets are formed by the coherent excitation of several non-degenerate Rydberg eigenstates, and there is an increasing interest in their dynamic behaviour and its relation to classical mechanics (the eigenstates' time evolution mimics the motion of a classical particle).

Several presentations were devoted to the study of **single- and multi-photon processes** resulting from the interaction of intense light with atoms. The availability today of high-intensity lasers, such as the table-top terawatt (T^3) — "big table-top" — laser, makes it possible to generate picosecond pulses with field strengths up to 100 times stronger than the field experienced by the electron of the hydrogen atom in the first Bohr orbit. When atoms are irradiated with these intense pulses, new interesting phenomena appear, such as multi-photon ionization, tunnelling ionization, barrier suppression, above threshold ionization (ATI), and high harmonic generation. J.-P. Connerade and co-workers (Imperial College, London) reviewed several aspects related to some of these phenomena, particularly questions concerning the extent to which these phenomena may reveal new characteristics specific to the atom under study (*e.g.*, are the atomic features swamped by the effects of the strong field?). Present controversies

LIDAR Measurements of Volcanic Fluxes

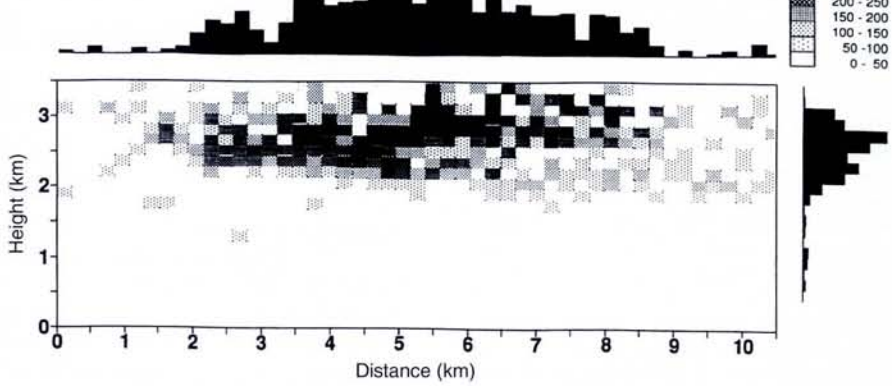
LIDAR, an acronym for light detection and ranging — the optical counterpart to radar — is sometimes referred to as laser radar. Differential absorption LIDAR techniques have been developed to the point that they can be used to make range-resolved measurements of atmospheric polluants, such as the flux of SO_2 above active volcanoes (an important issue for monitoring volcanic activity and environmental effects). This remote sensing technique can be considered to be an applied version of time-resolved laser spectroscopy, which in basic atomic physics is used for measurements of excited state lifetimes or level splittings employing quantum-beat phenomenon. The delayed detection of photons in laser radar is due to the passage of the photons through the atmosphere before being scattered back to a receiving telescope, rather than the delay in an excited state with a finite lifetime. It was this close resemblance between the techniques which constituted the starting point when laser radar research was taken up at Lund by our basic atomic physics group about 20 years ago.

Using an advanced mobile system aboard the Italian research vessel Urania, the Swedish group, together with Italian partners (CNR-Biofiscia, Pisa, and CNR-Geocronologia, Pisa) recently measured the total flux of sulphur dioxide from the Italian volcanoes Etna, Stromboli and Vulcano [Edner H. *et al., J. Geophys. Res.* **99** (1994) 18827]. The transmitter was a frequency-doubled dye laser, pumped by a Nd:YAG laser, firing 10 mJ pulses vertically as the ship made traverses under the volcanic plumes. Every second laser pulse was tuned to the SO_2 absorption line at 299.3 nm, while the intermediate pulses were fired at a nearby non-absorbed reference wavelength (300.0 nm). A 400 mm in diameter telescope received the on- and off-resonance LIDAR return signals, which are mainly caused by elastic Mie scattering off atmospheric aerosols, and averaging of the two kinds of transients was performed in separate computer memories. Finally, the range-resolved signals were divided for each range interval, thus revealing differential intensity effects due to SO_2. Influences owing to non-uniform distributions of aerosol particles were then also eliminated.

Data from a September 1992 passage under the Etna plume are shown in the figure. It can be seen how the plume, emitted from the crater at an elevation of about 3300 m and at a distance of about 23 km, has spread horizontally over the Straight of Messina. By multiplying the concentration data given in the figure by the wind velocity it is possible to obtain the total flux; in this case about 50 tonnes/hour. Corresponding numbers for Stromboli and Vulcano were found to be 6 and 1 tonnes/hour, respectively. Simultaneous measurements by the so-called DOAS (differential optical absorption spectroscopy) technique using the blue sky as a passive light source were also performed. Only the path-averaged value is obtained in this case, and a correction must be applied since part of the light is scattered inside and below the plume rather than above the plume. The LIDAR measurements allow a calibration of the data obtained with the simpler DOAS technique.

A new measurement campaign of the same kind was made in September 1994 on Mount Etna, but this time also involving scientists from the Volcanological Institute in Catania. The Catania group used simultaneously a correlation spectrometer (a so-called COSPEC instrument), which like DOAS analyzes the spectral content of the sky's radiation. Measurements of this kind will allow an absolute calibration of correlation spectrometric measurements that have being performed at many volcanoes for a number of years.

S. Svanberg
Lund Institute of Technology



An example of the SO_2 distribution over a vertical section through the plume from Mount Etna on 5 September 1992 as it spread across the Straight of Messina. The data were obtained using range-resolved LIDAR measurements from aboard a ship as it passed underneath the plume. Integration of the data leads to the flux of SO_2 from the volcano — Europe's largest and most studied.