bursters). Suffice to think of the role of Type Ia supernovae in the chemical evolution of galaxies and clusters of galaxies, or in providing a tool to measure the variation with cosmological time in the rate of universal expansion. For over 15 years two scenarios have been considered without being able to decide among them. In common to both is the basic mechanism: the thermonuclear explosion of a white dwarf (WD) accreting material until a critical mass is reached. But the two options diverge on the nature of the mass donor: a giant star filling its Roche lobe in the single degenerate (SD) scenario, another WD spiralling in due to gravitational wave radiation in the double degenerate (DD) scenario. Searches for DD systems have been only partly successful, being painfully slow at 4-m-class telescopes. The VLT now offers a chance to thoroughly address this problem, by checking a great number of WDs for radial velocity changes due to orbital motion. Unfortunately, the surface density of WDs is too low for exploiting the high multiplex of FLAMES (just 2 or 3 per square degree down to magnitude 20). However, WDs are all over the sky, and a snapshot survey with UVES will be ideal for filling in gaps in the night schedule when UT2/Kueyen will be used in Service Mode. At the high resolution of UVES, DD systems could be easily identified with just two short exposure spectra, with further observations allowing to determine the period. In five years, with a few minutes per WD, of order of 1000 WDs could be checked for binarity by investing just a few percent of the fraction of the UVES time that will be operated in service mode. Besides possibly finding a number of SNIa precursors, such a survey would provide unique information on the endpoints of interacting binary-star evolution, as well as a unique database of WD spectra.

Some among the stellar astronomers may have had the perception of the access to VLT data being overwhelmingly difficult. Actually, quite the opposite is going to be true: the flow of stellar data from the VLT is likely to be so high that a major fraction may not be promptly processed and exploited for shortage of astronomers who can do it. For example, it is estimated that with FLAMES absorbing some 80 nights/year for stellar studies, about 400,000 high-resolution spectra will be obtained during the first five years of operation[1]. Like all VLT data, all these spectra will become publicly available one year after the observations, allowing others than the proposing group of astronomers to refine (or even anticipate!) the scientific analysis. This will be especially interesting in the case of stellar high-spectral-resolution studies, in which the scientific result is at least as dependent on the actual modelling as it is on the quality of the original data. Rather than being a threat for stellar astronomers, the VLT offers to this component of the ESO community a great deal of opportunities. Deadline for applications for Period 65 is October 1, 1999.

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[1] For comparison, note that high-resolution spectra are presently available for just a dozen stars in the Galactic bulge.

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VLT Instrumentation Renewal

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I. The Rationale

At the time of this writing, ESO, with a major contribution from its community, is embarked on the so-called first-generation VLT instrumentation plan, with eleven different instruments for as many foci of the VLT, plus four instruments for the VLTI. The first two instruments (ISAAC and FORS1) have just been put in operation, with two others (UVES and FORS2) planned to join them in about 9 months. Succeeding in this ambitious endeavour is our present first and utmost priority.

When this major effort is completed around 2003–2004, we will then be faced with the prospect of almost immediately restarting new instrumentation, as the first instruments installed will be well in the midst of their likely 10–12 years useful life.

Peering just a little bit into a crystal ball, one can see indeed at least three different rationales which will likely push towards a substantial renewal of the presently planned first instrumentation complement of the VLT, namely:

- shifts in emphasis between major astronomical fields to be addressed with the VLT, as well as within these fields,

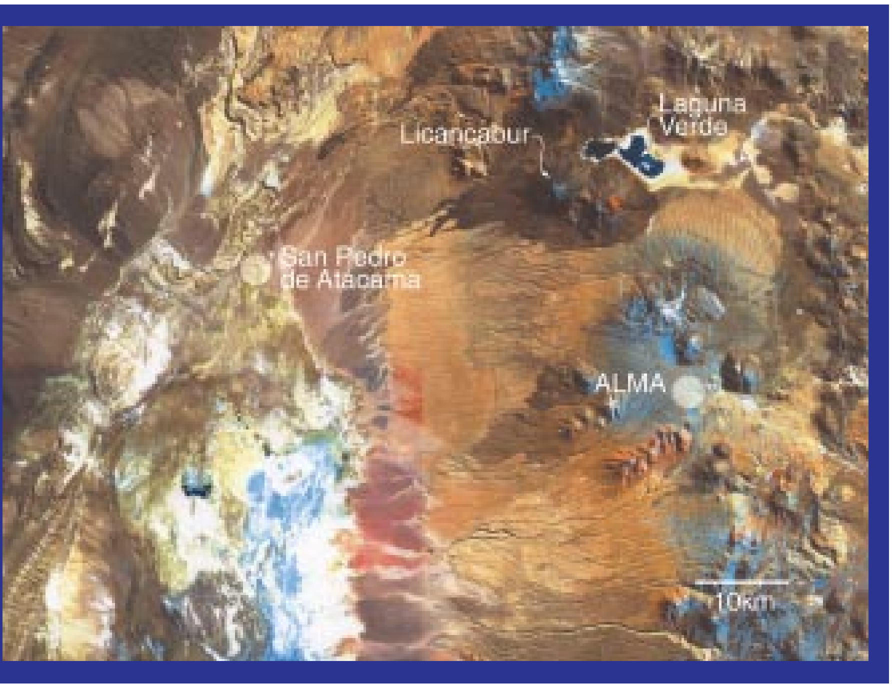
(Continued on page 18)

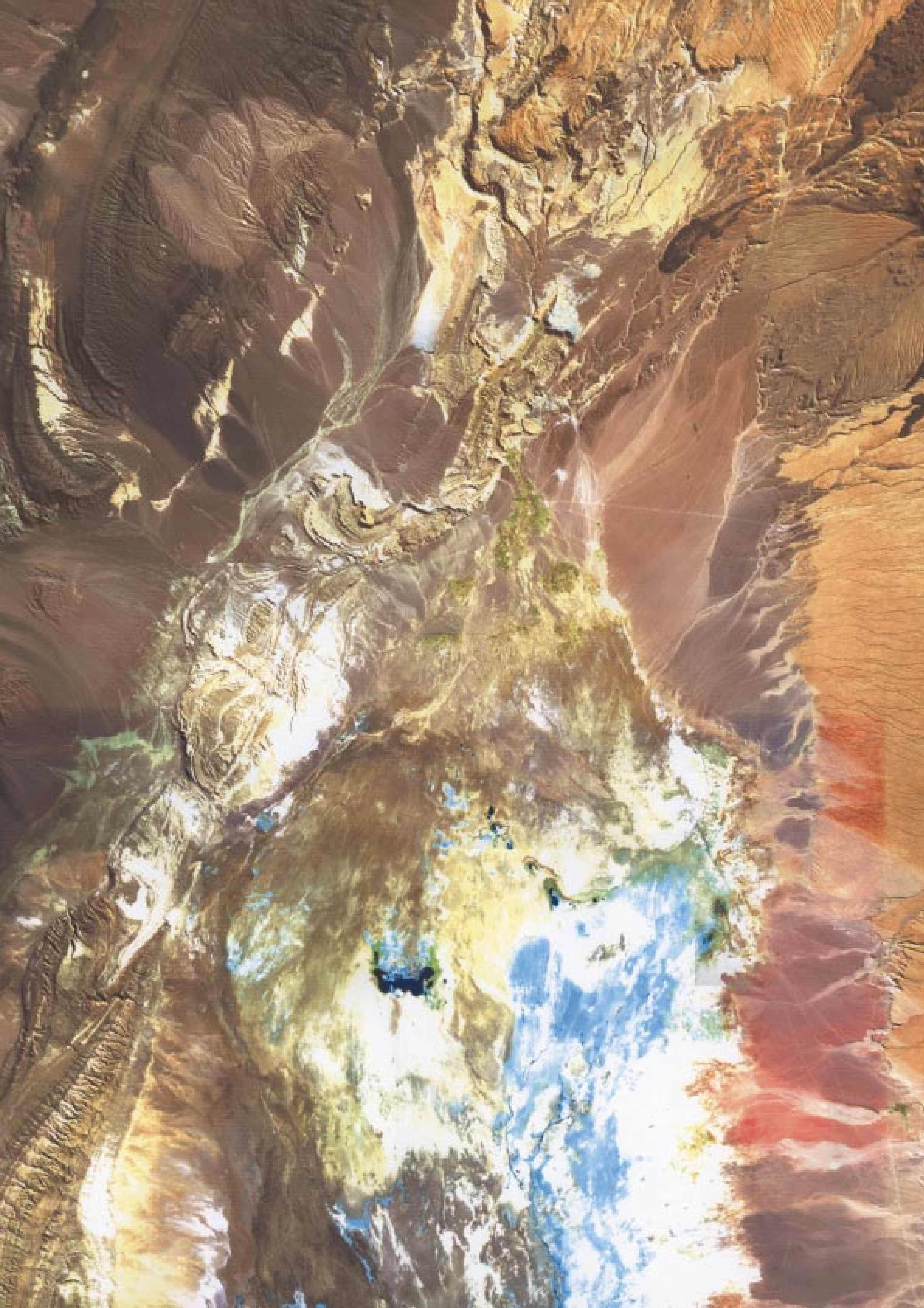
Centrefold

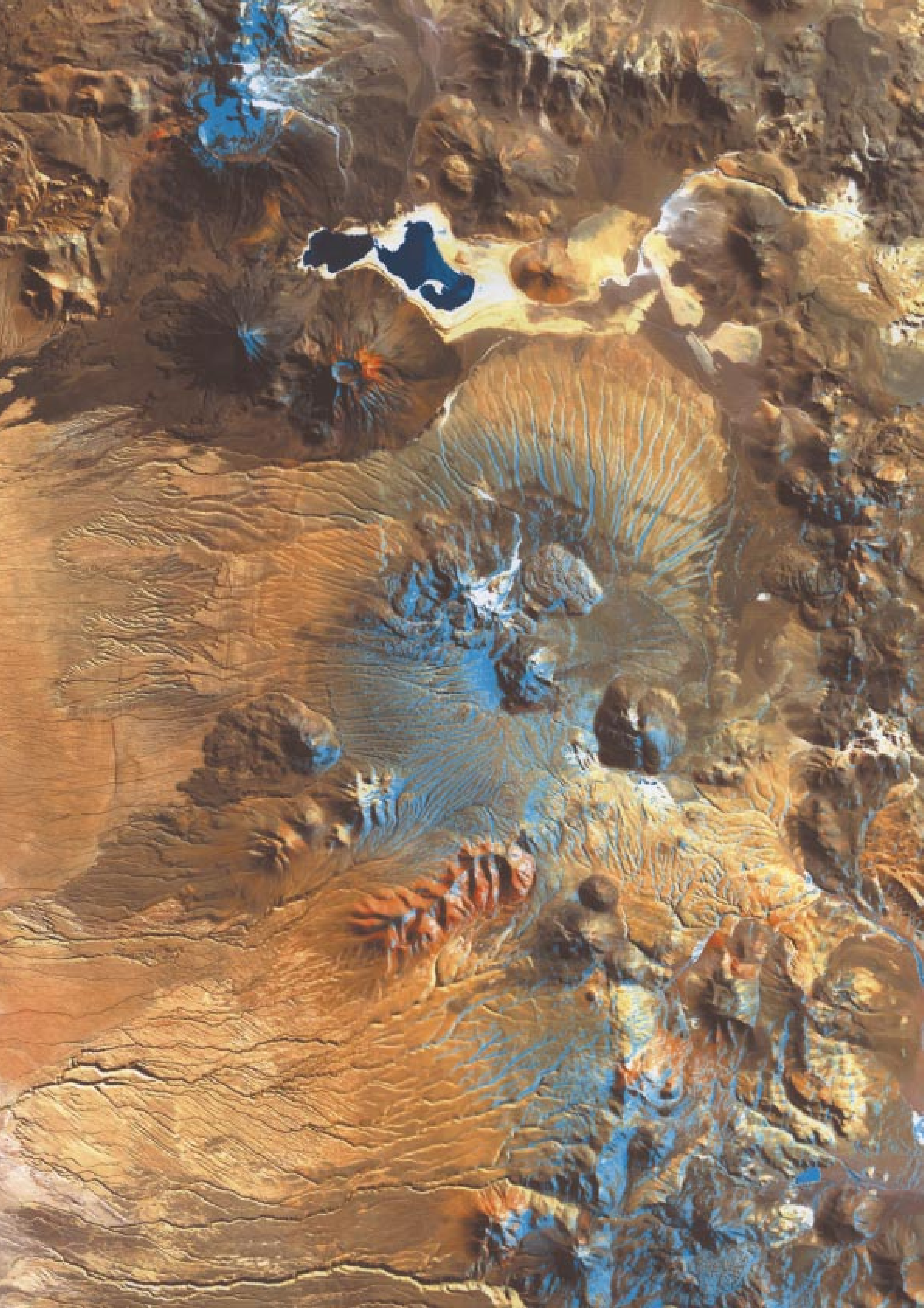
Satellite image showing the proposed location of ALMA, the Atacama Large Millimetre Array (see article on page 7 in this issue of The Messenger). Also indicated are the town of San Pedro de Atacama, the prominent volcano Licancabour, and the Laguna Verde.

This image is a composite of three exposures in spectral bands at 1.6 μm (rendered red), 1.0 μm (green) and 0.5 μm (blue). The horizontal resolution of the false-colour image is about 30 metres. North is at the top of the photo.

The image was produced in 1998 at Cornell University (USA), by Jennifer Yu, Jeremy Darling and Riccardo Giovanelli, using the Thematic Mapper data base maintained at the Geology Department laboratory directed by Bryan Isacks, and is reproduced here with their kind permission.







(Continued from page15)

- a seismic change in the level of competition in the 8-m-class club with the advent of the NGST in 2007+, given its huge natural edge, especially beyond $\lambda \sim 2.2\ \mu$m,
- steady advances in the relevant technological fields, some leading to upgrades of existing instruments (e.g. lower-noise detectors), but others requiring brand new instrumentation to fulfil their potential (e.g. high-order adaptive optics at visible wavelengths).

II. The VLT and Observational Cosmology

Observational Cosmology is widely perceived as the key scientific field for 8-m-class telescopes, at least for the next decade, with the goal of unravelling geometric (the underlying structure of the Universe) and evolution (galaxy formation) effects.

For the determination of the structural parameters of the Universe (H_0, q_0, Λ, …), much hope resides in post-COBE microwave background fluctuations determinations from dedicated satellites, but two alternative ground-based avenues still warrant being pursued, namely wide-field weak gravitational shearing and the use of SNIa's as standard candles. VIMOS will be our main tool for deriving weak shearing and must also provide an effective, if time consuming, way to detect high *z* (> 1) supernovae. For weak shearing, the main difficulty will be to get a highly stable spatial point-spread function over the large $14' \times 14'$ field of the instrument. It is presently quite uncertain how well that can be achieved at the VLT with its actively controlled M1/M2 mirrors. This important issue will be thoroughly checked during VIMOS commissioning in mid-2000.

Present emphasis in evolution studies lies in studying the early history of (massive) Star Formation. This is done either directly from the measure of the stars near-UV continuum or indirectly, using optical emission lines, e.g. the Hα recombination line, as a probe of their far-UV fluxes. A major by-product of these studies is a quantitative determination of the early chemical evolution in the Universe. In the next years, this is quite likely to move to the even most difficult task of determining the early history of mass assembly in the Universe, in the $z = 1$ to 5 redshift range. This new domain will, of course, be one of the main hunting grounds of the NGST. Nevertheless, much would still be addressable from the ground, with an adaptive optics enhanced ($0\farcs1$–$0\farcs2$ angular resolution), 0.6 to 2.2 μm wavelength range, $\Re \sim 3{,}000$ spectral resolution, integral field spectrographic capability. Such an instrument would permit the measurement of the mass distribution of faint galaxies up to $z = 4$, both from ionised gas ([OII] 3727Å) and from stellar light dynamics (CaII 3980–4227Å), and would be quite competitive in that redshift range w.r.t. NGST.

In addition, fishing for the first points of light ($z \gg 5$) in the Universe is too glamorous to be ignored. This, ultimately, will be the forte of NGST, but meanwhile will be pursued from the ground in a variety of ways: detection of rare high *z* quasars with ΩCAM at the VLT Survey Telescope; detection of I, Z or perhaps even J dropouts[1] with VIMOS and NIRMOS. We are on the other hand currently lacking one niche capability, viz. a tuneable filter to search for faint emission around high *z* objects (clustering around QSOs of known redshift, cluster member emission lines galaxies, etc.). Possibly, this capability could be inserted in a present VLT instrument, e.g. FORS1. In that application, however, very long integration times on single fields (> 100 hrs) are usually required, which may point to using e.g. the NTT at the La Silla Observatory instead of a VLT Unit Telescope.

III. The VLT and Large Scale Structure

We are investing heavily in this field, with VIMOS and NIRMOS for the study of the large-scale distribution of baryons, in the form of individual galaxies. In addition, UVES, with its eight simultaneous objects high spectral resolution capability in a half a degree field, should become a significant player in the study of dark matter large-scale distribution from the Lyα forest in front of high-*z* quasars.

One way to increase even more our capabilities in that domain would be to use the full 600 fibres potential capacity in a 27′ diameter field of FLAMES on Kueyen (UT2). This would serve as the optical spectroscopic arm of VST-based surveys, on a variety of astrophysical objects (QSOs, intermediate redshift clusters, etc.). Another avenue would be to build a new fully cryogenic multi-object capability, in order to pursue NIRMOS galaxy surveys to higher redshifts. This would be technically demanding (use of exchangeable cryogenic masks or perhaps programmable 2-D micro-shutter arrays) and potentially quite expensive, as only a truly wide-field capability (> 20′) could remain competitive in the NGST era.

IV. The VLT and Exoplanets

This domain is rapidly developing as a major new frontier in observational astronomy. We are already investing heavily at ESO with a variety of observing techniques: statistics of planetary systems from gravitational micro-lensing with ΩCAM at the VST; radial velocity detection with HARPS at the La Silla 3.6-m; proper-motion detection with PRIMA at the VLT combined interferometric focus. Niche observations will occasionally be addressed with VLT instruments, e.g. radial velocity measurement of faint promising candidates with UVES and, possibly, direct detection of 51 Pegasi-type planets with CRIRES.

V. VLT vs. NGST

The NGST will basically crush any ground-based competition in two domains:

– low-resolution spectroscopy ($\Re = 100$ to 1000) at <u>all</u> $\lambda > 2.2\ \mu$m, and probably up to 25–30 μm;

– medium-field ($\sim 5' \times 5'$) imagery at all $\lambda > 0.6\ \mu$m, except if/when efficient spectral hole burning filters could suppress all night sky emission in a fair fraction of the 0.6–1.8 μm wavelength range, which is far from technically ensured at present.

On the other hand, whole observational domains will stay largely untouched, especially:

– large-field surveys for building massive data base a la SLOAN Survey and/or for the detection of rare objects;

– high spectral resolution work, with presently at the VLT, UVES, CRIRES and the higher resolution modes of VISIR.

VI. Conclusion: Potential Avenues

We are led to a number of potentially interesting new instrumental avenues, namely:

- A "Phase II SINFONI" for 1.1 to 2.5 μm integral field spectroscopy with a larger field and higher, but still moderate order, Adaptive Optics corrections as a single (faint) object capability competitive w.r.t. NGST;
- A much more technically ambitious optical version of the above, using higher-order Adaptive Optics technology developed in the framework of the 100-m-diameter OWL feasibility study, and going down to 0.5 μm or even below;
- A cryogenic extension of NIRMOS up to the K band for higher *z* galaxy surveys;
- A multi-fibre, half a degree field, spectroscopic survey capability;
- A super-UVES ($\Re$ up to 10^6), using high-order Adaptive Optics, for the study of the local Interstellar Medium.

This is not a shopping list, but only a proposed preliminary set of basic facts and guiding principles. Hopefully, this is also the very first step towards building in the coming years a flexible plan for an orderly renewal of the first generation of VLT instruments. A first round of discussions has been done within the ESO Faculty and the issue is now in the hand of our community. This paper is in fact a slightly edited version of a report presented last May to the ESO Scientific and Technical Committee (STC), which has set up a subcommittee to investigate this whole issue.

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[1] Stellar continuum below a rest frame wavelength of 912 Å goes sharply to essentially a zero value, because of huge absorption by neutral hydrogen in the line of sight. This characteristic spectral signature, shifted to wavelengths accessible from the ground by the redshift of the object, is a major cosmological tool since the seminal work of Steidel. An e.g. B dropout is a galaxy whose continuum drops to zero in the B band and below.