and reach full diffraction performances. The ESO ADONIS PSFs show a variability, which is common to AO systems. It is this variability and the lack of a precise frame-by-frame PSF determination that makes post-processing of the data difficult. The iterative multiframe deconvolution method described takes successfully advantage of this intrinsic variability.

The linearity of the algorithm and its preservation of photometry is demonstrated on the four star simulations.

Multi-frame iterative myopic deconvolution enforces the very important constraint that observations of the same object will yield a common object result. Some prior PSF information is extremely useful in reducing the search space for the solution as demonstrated by the R Aquarii results.

Observations of a PSF calibrator, as demonstrated here, make an excellent initial PSF estimate, and this can be further strengthened by application of the PSF constraint. A variation on this approach has been utilised by Conan et al. (1997) and Véran et al. (1997). They have demonstrated that a very good initial PSF estimate can be obtained from a statistical analysis of the residual wavefront errors. Currently, this approach is applicable only to AO systems using photon counters, but it should be extendable to wavefront sensor systems using detectors with read-out noise as well, such as CCDs. Combined statistical PSF estimation and blind deconvolution post-processing has been discussed by Fusco et al. (1998) and Christou et al. (1997).

6. Acknowledgements

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LATEST NEWS

“First Light” for VLT High-Resolution Spectrograph UVES

(Excerpt from ESO Press Release 15/99, 5th October 1999)

A major new astronomical instrument for the ESO Very Large Telescope at Paranal (Chile), the UVES high-resolution spectrograph, made its first observations of astronomical objects on September 27, 1999. The astronomers are delighted with the quality of the spectra obtained at this moment of “First Light”. Although much fine-tuning still has to be done, this early success promises well for new and exciting science projects with this large European research facility.

Astronomical Instruments at VLT KUEYEN

The second VLT 8.2-m Unit Telescope, KUEYEN (“The Moon” in the Mapuche language), is in the process of being tuned to perfection before it will be “handed” over to the astronomers on April 1, 2000.

The testing of the new giant telescope has been successfully completed. The latest pointing tests were very positive and, from real performance measurements covering the entire operating range of the telescope, the overall accuracy on the sky was found to be 0.85 arcsec (the RMS-value). This is an excellent result for any telescope and implies that KUEYEN (as is already the case for ANTU) will be able to acquire its future target objects securely and efficiently, thus saving precious observing time.

The three instruments foreseen at KUEYEN are UVES, FORS2 and FLAMES. They are all dedicated to the investigation of the spectroscopic properties of faint stars and galaxies in the Universe.

The UVES Instrument

The Ultraviolet Visual Echelle Spectrograph (UVES) is the first instrument on Kueyen. It was built by ESO, with the collaboration of the Trieste Observatory (Italy) for the control software. Complete tests of its optical and mechanical components, as well as of its CCD detectors and of the complex control system, were made in the laboratories of the ESO Headquarters in Garching (Germany) before it was fully dismounted and shipped to the ESO Paranal Observatory, 130 km south of Antofagasta (Chile). There, the different pieces of UVES (with a total weight of 8 tons) were carefully reassembled on the Nasmyth platform of KUEYEN and made ready for real observations.

UVES is a complex two-channel spectrograph that has been built around two giant optical (echelle diffraction) gratings, each ruled on a 84 cm × 21 cm × 12 cm block of the ceramic material Zerodur (the same that is used for the VLT 8.2-m main mirrors) and weighing more than 60 kg. These echelle gratings disperse the light from celestial objects collected by the telescope into its constituent wavelengths (colours).

UVES’ resolving power (an optical term that indicates the ratio between a given wavelength and the smallest wavelength difference between two spectral lines that are clearly separated by the spectrograph) may reach 110,000, a very high value for an astronomical instrument of such a large size. This means for instance that even comparatively small changes in radial ve-

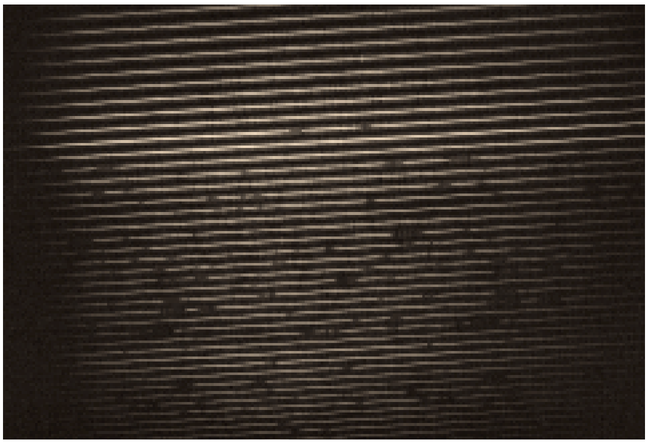
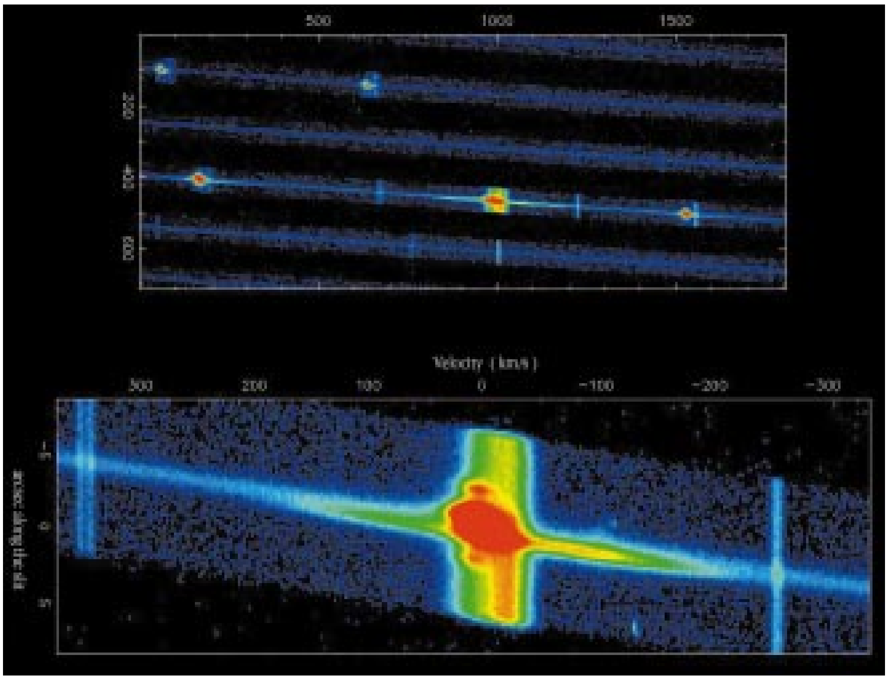


Figure 1: The power of UVES is demonstrated by this two-hour test exposure of the southern quasar QSO HE2217-2818 with U-magnitude = 16.5 and a redshift of z = 2.4. This UVES echelle spectrum is recorded in different orders (the individual horizontal lines) and altogether covers the wavelength interval between 330–450 nm (from the bottom to the top). It illustrates the excellent capability of UVES to work in the UV-band on even faint targets. Simultaneously with this observation, UVES also recorded the adjacent spectral region 465–660 nm in its other channel. The broad Lyman-alpha emission from ionised hydrogen associated with the powerful energy source of the QSO is seen in the upper half of the spectrum at wavelength 413 nm. At shorter wavelengths, the dark regions in the spectrum are Lyman-alpha absorption lines from intervening, neutral hydrogen gas located along the line-of-sight at different redshifts (the so-called Lyman-alpha forest) in the redshift interval z = 1.7–2.4. Note that since this exposure was done with the nearly Full Moon above the horizon, an underlying, faint absorption-line spectrum of reflected sunlight is also visible.

locity (a few km/sec only) can be accurately measured and also that it is possible to detect the faint spectral signatures of very rare elements in celestial objects.

One UVES channel is optimised for the ultraviolet and blue, the other for visual and red light. The spectra are digitally recorded by two highly efficient CCD detectors for subsequent analysis and astrophysical interpretation. By optimising the transmission of the various optical components in its two channels, UVES has a very high efficiency all the way from the UV (wavelength about 300 nm) to the near-infrared (1000 nm or 1 µm). This guarantees that only a minimum of the precious light that is collected by KUEYEN is lost and that detailed spectra can be obtained of even quite faint objects, down to about magnitude 20 (corresponding to nearly one million times fainter than what can be perceived with the unaided eye). The possibility of doing simultaneous observations in the two channels (with a dichroic mirror) ensures a further gain in data gathering efficiency.



This false-colour image has been extracted from an UVES echelle spectrum of SN 1987A, with a slit width of 1 arcsec only. The upper part shows the emission lines of nitrogen, sulfur and hydrogen, as recorded in some of the spectral orders. The pixel coordinates (X,Y) in the original frame are indicated; the red colour indicates the highest intensities. Below is a more detailed view of the complex H-alpha emission line, with the corresponding velocities and the position along the spectrograph slit indicated. Several components of this line can be distinguished. The bulk of the emission (here shown in red colour) comes from the ring surrounding the supernova; the elongated shape here is due to the differential velocity exhibited by the near (to us) and far sides of the ring. The two bright spots on either side are emission from two outer rings. The extended emission in the velocity direction originates from material inside the ring upon which the fastest moving ejecta from the supernova have impacted. Finally, there is a broad emission extending all along the spectrograph slit (here mostly yellow) upon which the ring emission is superimposed. This is not associated with the supernova itself, but is H-alpha emission by diffuse gas in the Large Magellanic Cloud (LMC) in which SN 1987A is located.

First Observations with UVES

In the evening of September 27, 1999, the ESO astronomers turned the KUEYEN telescope and – for the first time – focussed the light of stars and galaxies on the entrance aperture of the UVES instrument. This is the crucial moment of “First Light” for a new astronomical facility.

Much of the time during the first observing nights was spent by functional tests of the various observation modes and by targeting “standard stars” with well-known properties in order to measure the performance of the new instrument. They showed that it is behaving very well. This marks the beginning of a period of progressive fine-tuning that will ultimately bring UVES to peak performance.

The astronomers also did a few “scientific” observations during these nights, aimed at exploring the capabilities of their new spectrograph. They were eager to do so, also because UVES is the first spectrograph of this type installed at a telescope of large diameter in the southern hemisphere.

Many exciting research possibilities are now opening with UVES. They include a study of the chemical history of many galaxies in the Local Group, e.g. by observing the most metal-poor (oldest) stars in the Milky Way Galaxy and by obtaining the first, extremely detailed spectra of their brightest stars in the Magellanic Clouds. Quasars and distant compact galaxies will also be among the most favoured targets of the first UVES observers, not least because their spectra carry crucial information about the density, physical state and chemical composition of the early Universe.

Erratum

In the June issue of *The Messenger* (No. 96), page 26 (article by H. Lamy and D. Hutsemékers), formula 2 should read:

$$q = \frac{R_q - 1}{R_q + 1} \text{ where } R_q^2 = \frac{I_0^u / I_0^l}{I_{45}^u / I_{45}^l}, \tag{2}$$

$$u = \frac{R_u - 1}{R_u + 1} \text{ where } R_u^2 = \frac{I_{22.5}^u / I_{22.5}^l}{I_{67.5}^u / I_{67.5}^l},$$