VLT-UVES Long-Slit Spectroscopy

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In August 2005 we installed eight interference filters in UVES to be used with the red arm in visitor mode. The purpose of these filters is to isolate certain echelle orders to allow the use of a maximum slit length of 30″ in UVES.

The UV Visual Echelle Spectrograph UVES (D'Odorico 1997), which has been offered to the astronomical community at the VLT since 2000, is a two-arm cross-dispersed echelle spectrograph covering the wavelength range 300–500 nm in the blue spectral region and 420–1100 nm in the red spectral region with the possibility to use dichroics. The nominal resolution is 40 000 for a 1″ slit, and the maximum resolution that can be attained with a narrow slit or image slicer is 110 000 in the red and 80 000 in the blue with two-pixel sampling.

The scientific aim of the installation of interference filters in UVES is to study faint extended objects, for example planetary nebulae (PNe) or HII regions which are beyond the limit of a 4-m-class telescope. NTT-EMMI long-slit spectroscopy has been succesfully carried out since the beginning of 1996 (e.g. Corradi et al. 1996), with the main goal to study the morphology of PNe. Since PNe are the result of asymptotic giant branch (AGB) mass loss and their birth rate is very likely a function of metallicity, they are important tracers of intermediate-age stellar populations in galaxies. A spectroscopic study of the physical conditions and chemistry of PNe and HII regions is crucial to understand the metal enrichment during the galaxy lifetime.

PNe are known to display a variety of morphological components, such as multiple shells, extended halos, knots, bipolar lobes, jets and rings, and the detailed analysis of the structure of these components provides an important insight into the processes governing PNe formation and evolution. The most important parameter to describe the dynamics and various morphological components is the velocity field derived from spatially resolved PNe. Numerous recent studies of PNe are aimed especially at disentangling the full velocity fields by high-resolution spectroscopy. As an example, a study of the structures of faint extended ionised haloes of PNe which are believed to reflect the previous history of heavy mass loss on the AGB, requires the precise knowledge of internal velocity fields. The availability of the high-resolution UVES long-slit mode will give the opportunity to carry out an accurate kinematical analysis of faint halo structures and their puzzling mysterious systems of rings discovered in HST images (e.g., Terzian and Hajian 2000, Corradi et al. 2004). We note that at present, only very few other high-resolution spectrographs at 8–10-m class telescopes in the world

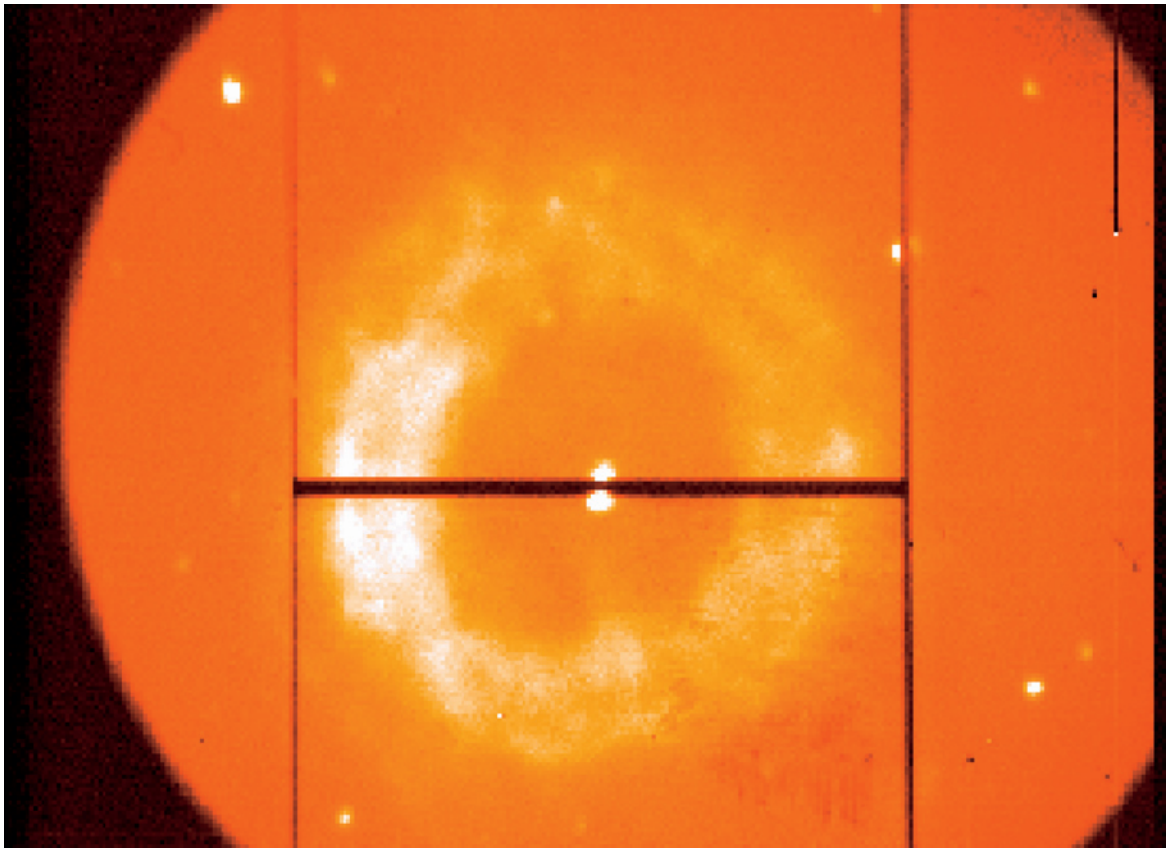

Figure 1: The UVES slit viewer image of the planetary nebula NGC 6369.

have a long-slit capability. Thus, introducing the high-resolution long-slit mode in UVES by adding interference filters to remove the other orders, taking advantage of the full slit length should be of great interest to astronomers working on the kinematics of ionised nebulae and galaxies.

The central wavelengths of the filters were chosen to permit observations of the most important emission lines in extended objects. The order for the filter manufacture was placed to the Andover Corporation in March 2005 and the filters arrived in Garching in June 2005. All eight filters were installed in the UVES red arm filter wheel in August 2005.

The filters and their central wavelengths are: Hα (656.6 nm), Hβ (486.1 nm), O III (500.7 nm), O III (436.3 nm), N II (575.5 nm), O I (630.0 nm), S II (672.4 nm), and He II (468.6 nm). Spectral ranges and peak transmissions are given in Table 1. The FHWM of the Hα filter was chosen to allow simultaneous observations of Hα with close-by [N II] lines with wavelengths at 654.8 nm and 658.3 nm, respectively, whereas the S II filter allows one to observe simultaneously the [S II] 671.7/673.1 nm doublet. The transmission curves for all eight filters are avaible in the UVES components database, accessible through the ETC (*http://www.eso.org/observing/etc/bin/gen/form?INS.NAME=UVES++INS.MODE=spectro*).

A first sky test with the new filters was carried out in the second half of August 2005. The planetary nebula NGC 6369, which has a diameter of 33.″0 × 32.″7 (Tylenda et al., 2003), was observed with the UVES red arm using CD#3 and a slit width of 0.″6 (R ~ 70 000). The slit view image of this nebula is shown in Figure 1. The exposure time for the observations in each filter was 600 s. As at present there is no pipeline support for the reduction of the UVES long-slit mode, the spectra were reduced using both MIDAS-LONG package and the IRAF LONG-SLIT tasks. As an example, we present in Figures 2 and 3 two- and one-dimensional Hα and Hβ spectra of NGC 6369.

Our sky tests of the interference filters show that the UVES long-slit mode configuration can be successfully used for observations of extended objects with narrow spectral features.

References

D'Odorico, S., in "The Early Universe with the VLT", ed. by J. Bergeron, Springer 1997, 54
Corradi, R. L. M., Mampaso, A., Perinotto, M. 1996, The Messenger 85, 37
Corradi, R. L. M. et al. 2004, A&A 417, 637
Terzian, Y., Hajian, A. R., 2000, ASP Conference Series 199, 34
Tylenda, R. et al. 2003, A&A 405, 627

Table 1: New Interference Filters.

Name	Spectral range (nm)	Transmission
Hα	652.8–659.8	92 %
Hβ	484.2–488.0	72 %
O III 500.7	498.6–502.7	71 %
O III 436.3	434.8–437.9	69 %
N II 575.5	573.0–578.5	86 %
O I 630.0	626.9–633.4	90 %
S II 672.4	668.7–676.0	86 %
He II 468.6	466.8–470.3	79 %

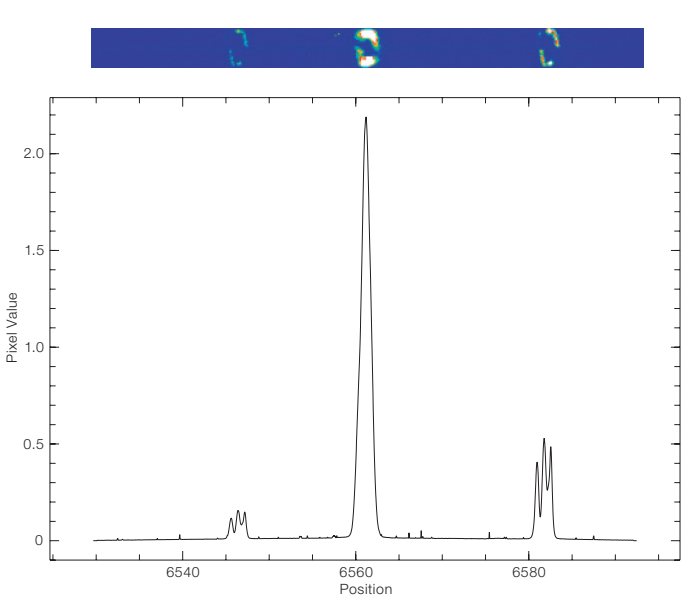

Figure 2: Hα and [N II] spectra of NGC 6369.

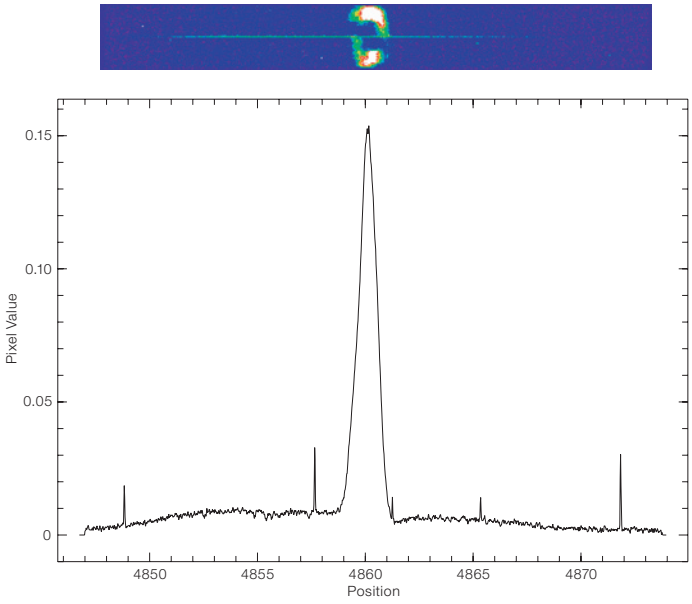

Figure 3: Hβ spectra of NGC 6369.