centre and anti-centre directions, and at different galactic latitudes.

For every sub-sample, the distributions of objects in function of their bolometric luminosities and mass loss rates will be evaluated. As the samples contain stars of different pulsational behaviours, the relationships between type of variability, luminosity and mass loss rate will be investigated. Initial masses of carbon star progenitors will be derived through their distribution perpendicularly to the galactic plane. Because metallicity depends on the galacto-centric distance, its effect on the formation and evolution of carbon stars will be sorted out. Also, the mass-return rate from carbon stars will be determined as a function of the distance to the galactic centre.

This investigation will thus cast new light on the physical properties of carbon stars in different physical and chemical environments, and on the chemical evolution of the interstellar medium throughout the Galaxy.

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## PROFILE OF A KEY PROGRAMME:

# High Precision Radial Velocity Determinations for the Study of the Internal Kinematical and Dynamical Structure and Evolution of Young Stellar Groups


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### Purpose

Presently observable sites of star formation corroborate the viewpoint that the birth of stars occurs in groups. Such groups remain gravitationally bound for a shorter or a longer time interval and are catalogued as open star clusters or associations depending on their compactness. As far as the dynamical state of these groups is governed by the conditions in the initial phases of cloud fragmentation, star formation and nebular gas expulsion, they contain valuable information about the star birth processes and the early dynamical evolution of a star forming region (1). Evidently, the younger the groups, the more the present state reflects the initial characteristics.

An important key to the progress in such studies is the availability of information on the internal kinematics in stellar groups: the internal velocity dispersion, and its spatial and stellar mass dependence (2). That purpose imposes an accuracy of the order of a few km/s on empirically derived kinematical quantities for a considerable number of stars covering a large range in stellar mass (3). Nowadays, instrumental technology is at the point that makes such observational efforts feasible. CCD echelle spectroscopy on ground-based telescopes offers the opportunity to record good quality (S/N > 50) spectra over the extended wavelength range required in order to acquire sufficient spectral information in early-type stars. CASPEC at the 3.6-m ESO telescope provides the stability and efficiency to obtain a reasonably large set of radial velocities (RVs) with an accuracy that is limited by stellar atmosphere physics or standard system calibration rather than by the instrument. We concentrate on the 3 subgroups in the Sco-Cen OB association and on the more distant young cluster NGC 2244 in the Rosette nebula, aiming at a detailed survey of about 500 O-F type respectively 50 O-A0 type stars. The radial velocity study is part of a continuing observing programme on nearby clusters and associations, including Walraven photometry (4, 5, 6), astrometry from HIPPARCOS, mapping of molecular gas (7), and spectroscopy for classification (6). The theoretical side of our study consists of N-body hydrodynamical simulations of stars embedded in gas (8). Reliable empirical information on the dynamical state of young stellar systems is essential as input in such numerical experiments and in theoretical models.

### Interpretation of the Data

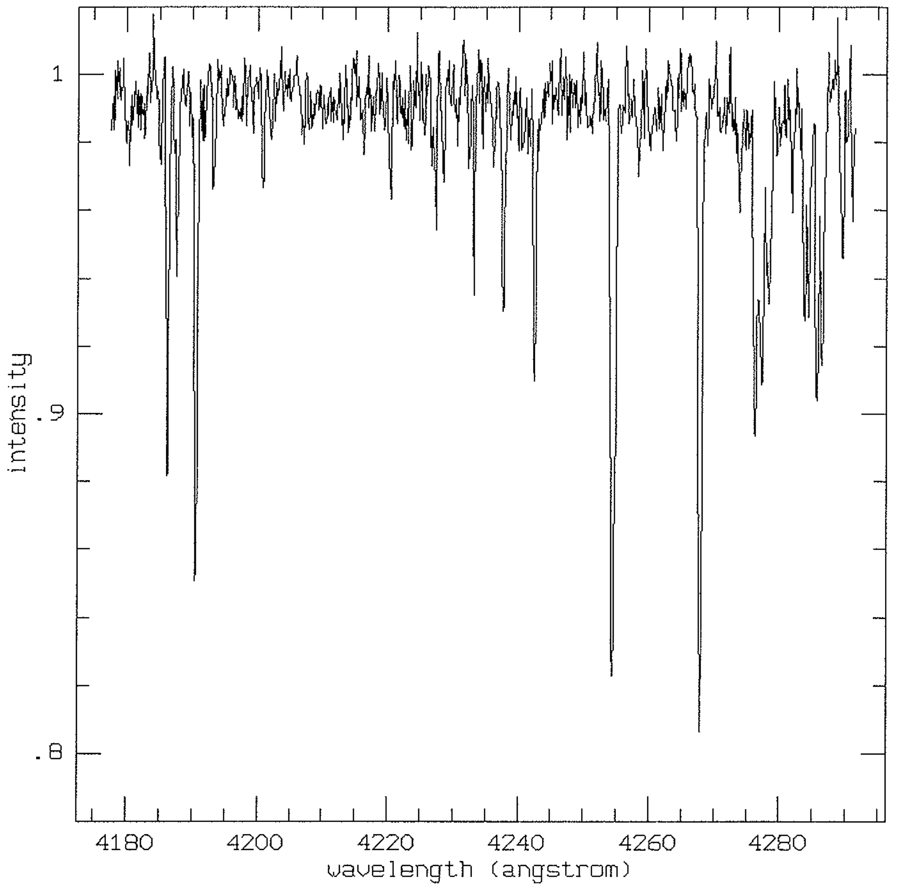
The determination of RVs in early-type stars with the required precision is, for several reasons, a challenge. The application of CORAVEL in RV work has opened new frontiers in the study of late-type stars, based on a high quality RV standard system. The use of the CORAVEL technique is unfortunately not extendable to earlier types. The establishment of a better standard system at early spectral types is still essential and our observations are expected to contribute to this task (9). RVs will be measured by the cross-correlation technique (10), although attention will have to be paid to discern systematic effects possibly originating from subsystems of spectral lines; systematic atmospheric motions in OB stars might bias the apparent RVs and could be detectable from lines formed over different atmospherical depths. As a by-product, this should almost certainly lead to addition-al insights into the atmospheric structure of hot stars.

It is essential, although time consuming, to disentangle effects due to binarity from effects reflecting the kinematics of the stellar group (11). Especially the lack of recognition of wider binaries with an RV amplitude of the order of 10 km/s might significantly influence the conclusions. Hence, repetition of RV observations is necessary and will in turn increase our knowledge on binarity in the selected young stellar groups. The spectra will in addition allow a study of stellar rotation in these star groups (12).

In many respects, this project forms an extension towards the earliest spectral types of the key programmes of Mayor et al. and Gerbaldi et al. (described in the *Messenger* **56**), even when the primary scientific motivation is somewhat different. In addition to the common interest in radial velocities, the stars in Sco-Cen are also observed by the Hipparcos satellite, providing space motions when combined with the RVs. Using these, we hope to reconstruct the initial minimal volumes in which the star formation occurred which gave rise to the presently expanding Sco-Cen subgroups, and to discuss the possibility of sequential star formation (13).

### First Results

Strictly within the frame of the key programme, the first spectra have been obtained on 3 nights in May 1990. However, a limited amount of data has been obtained during the last three years with CASPEC and has resulted in the establishment of a stable, accurate wavelength calibration procedure (14) and an optimized echelle reduction method (15). Presently, we can concentrate on the proper radial velocity work. In NGC 2244 we detected a number of slowly rotating O and B stars (out of our current sample of 17, 5 had v·sin i <30 km/s), whose narrow lines are favourable to a very accurate determination of the RV (Fig. 1).




*Part of the CASPEC spectrum of NGC 2244-201, a 10th magnitude B1 V star. The strongest lines are OII 4185, OII 4190, NII 4242, OII 4254, CII 4267, a complex of OII lines around 4277A, OII 4283, SIII 4285 and OII 4286.*

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# The Status of the Hubble Space Telescope

As you have certainly learnt from the news media, the focussing tests carried out during last June revealed that the Hubble Space Telescope suffers from spherical aberration. The amplitude of the aberration is about half a wavelength rms and it has a negative sign, i.e. the marginal focus lays further away from the secondary than the paraxial one. The resulting Point Spread Function is characterized by a sharp core of about 0.1 arcsec surrounded by an extended "halo": unfortunately the core encircles only about 10–20% of the energy. The forthcoming issues of the ST ScI and ST-ECF Newsletters will contain more quantitative details on the problem.

Although the spherical aberration prevents HST to reach its "level 1" specifications (about 70% encircled energy within 0.1 arcsec) and has serious consequences on its imaging capabilities, the actual impact on the scientific output has to be evaluated a bit more carefully than what has been unfortunately done by the generic press. In particular, any comparison with the capabilities of