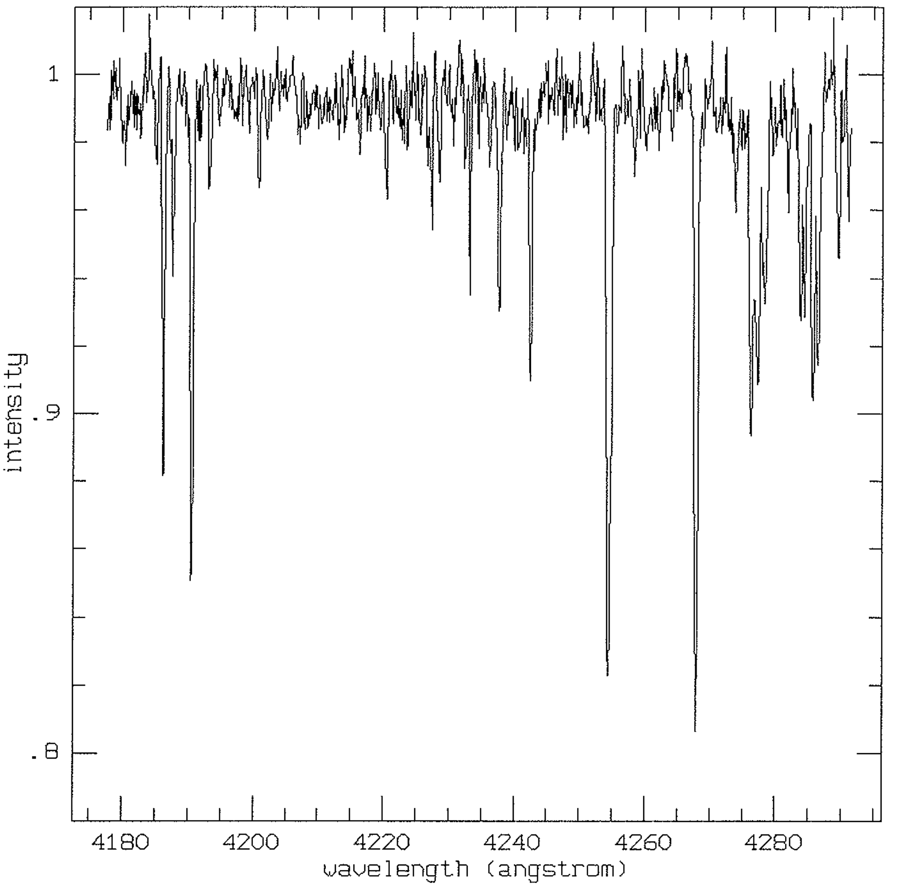
al insights into the atmospheric structure of hot stars.

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 ground-based telescopes has to consider the uniqueness of the UV imaging from space and the fact that, since the HST Point Spread Function departs considerably from a gaussian-like profile, spatial resolutions cannot be compared just by using the FWHM as a parameter. Moreover, the two HST spectrographs are less affected than the cameras and most of the scientific programs should still be feasible, albeit with an increase in the exposure times.

Currently, a Scientific Assessment Team has been formed at the ST Science Institute with the task of preparing an observing programme (to be carried out in August-September) which will allow a better evaluation of the actual performance of the scientific instruments. The relevant data will be made available to interested scientists shortly after the observation. Concurrently the Guarantied Time Observers and General Observers' proposals are being reviewed for feasibility and modification. More about this exercise will be published in the ST Newsletters, in the electronic Bulletin Board and communicated directly to the HST Principal Investigators.

On the front of correcting the problem, NASA intends to speed up the construction of the second generation instruments, in particular of the WF/PC II, which will include appropriate modifications in the optical design to compensate for the spherical aberration of the telescope. The situation of the ESA Faint Object Camera in the light of the HST performance will be reviewed in the coming weeks.

Considerable effort is also being invested in evaluating the applicability of different image restoration methods. ECF staff, in collaboration with ESO colleagues, is experimenting with different algorithms on simulated images which make use of the actual, aberrated, HST psf. The results will be presented to a specific workshop on the subject which has been organized by the ST Science Institute on August 21–22. Meanwhile the ECF continues to maintain contact with the European PIs who are involved in Cycle 1 observations offering assistance in the review and possible modification of their programmes.

P. BENVENUTI, ST-ECF

"Matching Error" (Spherical Aberration) in the Hubble Space Telescope (HST): Some Technical Comments

R. N. WILSON, ESO

Much consternation has been caused in the astronomical community because of the revelations since the last week of June that the Hubble Space Telescope (HST) has a systematic error giving an image with about 70 % of the geometrical light energy within about 1.5 arcsec diameter instead of less than the 0.1 arcsec predicted from its specification of "diffraction limited performance" for visible light (wavelength 500 nm). The error has been identified as mainly spherical aberration due to "matching error". The above quality figure has been quoted in a number of reports, but may include other errors (including residual focus error) of unknown amount. From more specific information on the amount of spherical aberration, I have calculated below that the spherical aberration error *alone* would give an image at best focus with 100 % of the geometrical light energy within about 1.5 arcsec diameter.

Before considering further the origins of this error, let us look at the meaning of the term "spherical aberration". Elementary text books on optics usually explain it as a "longitudinal aberration" as shown in Figure 1. Rays coming from the central part of the optical system (near its axis) focus at the point O on the axis, whereas those from the outer circumference focus at A. The sign of the aberration as shown above with A to the left of O is what a simple convex lens would generate, whereas in the HST it is probably the opposite. The distance AO is called the longitudinal spherical aberration and is about 40 mm in the HST. If the focus for the detector is chosen to be at O (the so-called paraxial or Gaussian focus), then the total transverse spread of the light has the diameter BC. It can be shown that, for the basic (so-called "third order") spherical aberration, the optimum focus reducing the diameter of the light patch to a minimum is at D, one quarter of the distance from A to O. This minimum diameter is called the "disk of least confusion" EF which is obviously one quarter of BC. Taking AO as about 40 mm in the HST, an exit beam of f/24, the diameter BC containing 100 % of the energy at the Gaussian focus is 6.0 arcsec; at the best focus it is 1.5 arcsec. These figures, expressing angular aberration, can easily be converted into the so-called "wavefront aberration" which gives the maximum phase error of the image forming light. This is 4.34 μm for the above figures and an aperture of 2.4 m for the HST. This wavefront aberration is the best physical measure of the error and is, in fact, exactly twice the maximum error on the mirror surface involved, referred to the Gaussian focus, which is therefore 2.17 μm. Frequently, the rms (root mean square) error on the surface has been quoted which is about one sixth of the above, or 0.36 μm, or somewhat more than half a wavelength of laser light of 0.632 μm. The above figures reveal how essential it is to define exactly what definition is being used, otherwise serious confusion results.

Let us now return to the probable origin of this spherical aberration error in the HST.

In the technical domain of the produc-

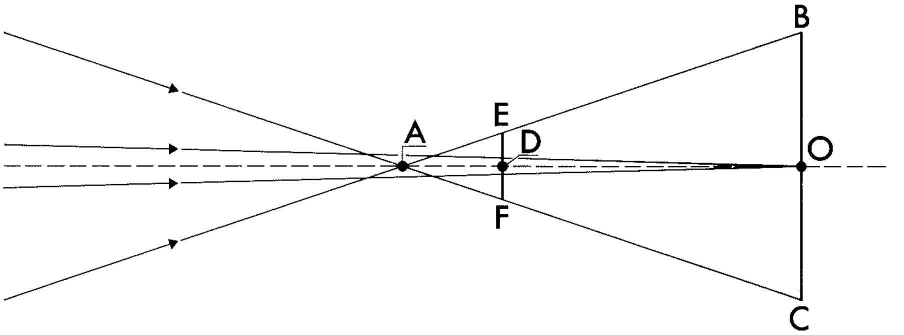

Figure 1: *Path of rays forming an image afflicted with spherical aberration.*