ACCURACY OF SPECTRAL CLASSIFICATION

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A knowledge of the spectral types of visual components is still basic to most intensive studies of visual systems. Although there are photoelectric techniques that give good quantitative information on certain classes of stars, the only way at present to identify most classes of stars, from mercury-manganese stars to barium stars, is by obtaining their spectra. The spectra can be obtained from objective prisms, slit spectrographs, or spectrum scans, but the important things are that they (1) show a large portion of the spectra, preferrably in the blue-violet for most classes of stars, (2) have sufficient resolution and signal-to-noise to identify many spectral lines, and (3) be standardized as an independent system. The last is important because if spectral type standards are changed so that they will agree with other information, such as colors, we lose the benefits of a comparison, such as deriving interstellar reddening.

Since the discovery of the two-dimensional Morgan-Keenan (MK) classification system about 40 years ago, there have been substantial improvements in speed, accuracy, and reliability. The speed of photographic plates has increased by about an order of magnitude during the past half-century, and solid-state detectors are adding one or two more orders of magnitude. Our telescopes and spectrographs tend to have better resolution and more freedom from systematic effects, such as changes in focus with wavelength. We can compare spectra on different plates with the very useful contemporary spectra comparators, which have improved classification accuracy by a factor of 2. And careful studies of individual stars have improved our selection of standards and identified true peculiarities. Now, for instance, it is obvious that Sirius is a metallic-line (Am) star with one-tenth of a spectral class between the calcium and metallic types, i.e. A0 and A1, whereas 15 or 20 years ago we would not have been able to say that.

How well, then, or how reliably can we classify stars? A good test came recently (Abt 1981) when I classified 865 stars in visual multiples. Of those, 44 stars had been classified independently by Morgan or Keenan. There were no systematic differences in type or luminosity and the random errors amounted to one-tenth of a spectral class (0.00 $\pm$0.10 s.e.) and 0.7 of a luminosity class (Abt - MK: -0.1 $\pm$0.7 s.e.). When my types for 331 stars are compared with those by dozens of other people, the differences are -0.02 $\pm$0.17 s.e. in spectral class and -0.1 $\pm$0.7 s.e. luminosity class. For stars from A0 to late M, one-tenth of a spectral class corresponds to about $\pm$150 K, while 0.7 luminosity class corresponds to ΔM_V = $\pm$1.5 mag. Therefore these represent the current accuracies of good-quality spectral classification for typical stars. These are less accurate by a factor of 6 than the best photoelectric

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photometry, but the visual classification has the advantages of being independent of interstellar reddening and being able to tell us more, such as spectral peculiarities.

Let me add a few comments about the classification program of visual multiples. I am classifying all the components brighter than B = 8.0 mag. in the Aitken double-star catalog. Of about 4000 such stars, the first list of 865 is in press. Some statistical results are as follows:

1. About 1% of the F-type dwarfs are obviously weak-lined. More sensitive techniques give a percentage of about 3%.
2. Among the A4-F1 main-sequence stars, 32% are found to be Am stars. Smith (1971) found a fraction of 31%.
3. Among the A0-A3 main-sequence stars, 5% are early Am, or Sirius-type, stars and 8% are Ap stars.

However, the primary reasons for this classification project are to determine what kinds of stars are involved in the visual systems that those at this colloquium and others are studying so carefully with other techniques, and to obtain approximate luminosities.

REFERENCES

Abt, H. A. 1981, Ap. J. Suppl., in press (March).
Smith, M. A. 1971, A. J., 76, 896.

DISCUSSION

SCARFE: How do you handle the stars that are not resolved on the slit and may therefore have blended or composite spectra?

ABT: If the stars are too close together to obtain separate spectra, I observe them together and say so. In some cases there are obviously composite spectra - an early and a late type star. If there are two stars of nearly the same brightness, they are often the same kind of star, and we don't learn very much. If they are very different in brightness, then the spectral type refers only to the primary.