SPECTROSCOPY-WHAT ARE THE NEEDS ONCE SPACE ASTROMETRY HAS GIVEN US A NEW DATA BASE

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I think the best way to start my talk is to recall what kind of spectroscopic information is available at present. Spectroscopic information can be of various kinds; starting from the simplest it may be:

a- a spectral type (unidimensional)
b- a spectral type plus a luminosity class (bi-dimensional type)
c- a description-more or less detailed
d- a quantitative analysis, which can be more or less sophisticated

At present this information is available for roughly:

Kind	Number	Annual growth rate
a	10^6	10^4
b	10^5	10^3
c	$2\text{-}3 \times 10^4$	
d	10^3	2×10

The four kinds of description answer in principle different questions. The simplest (a-type) information is mainly useful for preselection for other types of studies. Even if only approximate, the unidimensional spectral type is essential for preselecting stars for radial velocity spectrometers (which work only for stars later than A5) or photoelectric photometers (uvby works only for stars earlier than G5). Type b information provides a luminosity class and therefore permits to derive extinction and distance if a photometry is also available. At present time, it is good to remember that for 90% of the field stars, spectroscopic parallaxes are the only way to obtain distances. The two dimensional types also permit the elimination of the non-normal objects. This is again very important for other kinds of studies, like for instance H-beta photometry, where one can get a distance modulus, provided one knows that the star has no emission lines.

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Detailed descriptions or quantitative analyses do obviously furnish more information, but the number of objectives involved becomes rather small when compared with the number of stars observable from a satellite, so that we will omit them from further consideration.

Let me add the warning that although the data indicated in the table were published somewhere, this does not imply that they are easily accessible. It might be either that the publication is forgotten (who remembers who worked on a certain region in Auriga?), or that the star is identified by an unusual identificator (a bright star identified with a PGC number), or that its position is given for an unusual equinox. So my conclusion is that only those informations which are on magnetic tape are easily accessible-and unfortunately 70% of the unidimensional types are NOT on tape. This situation is not likely to change very soon, since the punching of 7.10^5 objects is a big and costly task.

The most valuable unidimensional catalogue, the HD, exists on tape. Observe however, that its limiting magnitude is NOT homogeneous; in the north it lies between 8.5 and 9.0, whereas in the south it goes beyond 9.5.

When we go toward fainter magnitudes, nothing systematic exists. Let me simply mention that we do have some systematic surveys for early type stars (O,B) like the "Luminous stars," the Stockholm and the Bonn surveys in the galactic plane and several detailed surveys in the galactic pole regions; the magnitudes go down to 11 or 12, but from a general point of view we are considering very small areas of the sky. When we next pass to bi-dimensional classifications, we have about 3.10^4 spectra of mostly stars brighter than 9^m. This material has been collected in several compilation catalogues (Jaschek et al, Kennedy, Buscombe) and is available on tape. However, it is rather heterogeneous and progresses slowly, by about 10^3 stars per year. For the benefit of the non-spectroscopists, Mercedes Jaschek has undertaken a selection of the "best" spectral types, if several ones do exist for the same object. The 3.10^4 stars of this catalogue are also available on tape.

The biggest effort to obtain a homogeneous coverage of the sky is being undertaken by Miss Houk. She is reclassifying all HD stars on objective prism spectrograms, starting from the south. According to the aüthor, the state of the project is as follows:

I	-90°	to -53°	3.6×10^4 stars	1975
II	-53	-40	3.5	1978
III	-40	-26	3.1	(1980)
IV	-26	-10	3.8	(1983)
...		90		1990:

the plates from -90° up to $+35^{\circ}$ are already taken, and plans are under

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way to observe the northern zones from Kitt Peak. It should be added that the plates contain many more classifiable spectra of stars fainter than the HD limit.

Plans of extending this work to fainter stars were discussed, but since each additional magnitude involves roughly a factor three in the number of stars, it seems that the HD project represents the limit of what can be done by visual inspection. If we want to go fainter, we must change techniques, and that is what many people have been trying. At the 1978 Vatican meeting, Schmidt-Haler has reviewed the situation of automated classification techniques in some detail. However, at present no system is yet operational, and none has produced a few thousand classifications in order to check its capabilities.

When considering fainter stars, a second problem which has to be considered is the overlapping of spectra. If one wants to avoid superpositions, one can go with 100 A/mm to 11^m. One can reach 14^m with D~1400 A/mm, using in both cases the same telescope (à Schmidt camera of 60 cm). This implies that when we go to fainter stars, our knowledge diminishes and one sees that the spectroscopy of fainter stars is rather difficult. One can of course circumvent that by eliminating unwanted stars, but to do so one needs preliminary information about <u>all</u> objects. To observe isolated stars is, of course, also possible, but suicidal for large numbers of objects. With a 300-cm telescope one can get in 16 minutes a 15^m star... with an image tube system. I have spent a considerable fraction of my time on the inventory of the things already existing or "around the corner." Let me now try to ascertain the impact of the new astrometric data.

As we have seen, for a large fraction of the stars observable with Hipparcos we do have, or expect to have soon, a two-dimensional classification, which goes together with an assessment of their normalcy. This I think is an essential thing to have for all stars to be observed; as we have seen it constitutes a basic need for either deriving distances or for applying other techniques.

If we should need to extend our survey to fainter magnitudes, it would seem that a determined effort should be made to get at least one of the automatic classification systems working.

When we get precise distances for many stars, we will be for the first time in condition to improve the luminosity criteria. So far we have had precise classifications and imprecise distances, which left us with the practically unsolvable problem to decide if the errors of spectroscopic luminosity classes are due to errors in the spectroscopy or to errors in the distances used for calibration. With Hipparcos we expect a redressment of the situation. This will undoubtedly lead also to a very close examination of the problem if "spectroscopic" or "photometric" parallaxes are better-- but to use the latter we must know if the star is normal or not.

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The two-dimensional types obtained by Miss Houk are derived from objective prism plates having a dispersion of 108 A/mm. The recent Atlases of Keenan-McNeil and Morgan-Abt-Tapscott use both higher dispersions, larger widenings and slit spectrograms. Because of this it seems possible to increase the accuracy of the classification. A determined effort should be made to secure spectra under such conditions for a large fraction of the stars for which accurate distances will become available in order to get the best possible classification.

With improved distances we should also be able to pin down possible abundance and/or population effects in absolute magnitude. Since the MK system deals mainly with population I objects, we can expect a new impetus to be given to an extension of the system toward other population types. In this respect we should also keep in mind that we cannot expect to have all these effects illustrated in the blue spectrum region. As Keenan has advocated many times, a determined effort should go into the use of the red and infrared regions.

So, in summary, I think that the arrival of many precise distances will gently push spectroscopists to do the following-

- to make operational automatic classification devices
- to make more spectroscopic data available by putting them in machine readable form
- to reexamine luminosity criteria
- to obtain improved spectrographic material for a large number of stars with well known distances
- to extend the MK system to other populations
- to reexamine other spectrum regions, specially in the red and infrared.