would be just *circular reasoning,* and, further, be subject to prejudice. Therefore, I take the liberty to believe only in the above-mentioned four distance indicators: Cepheids, Supernovae I, brightest M supergiants, and the Tully-Fisher relation.

I should like to add that the upper limit to the absolute luminosity of brightest red supergiants may be *constant* from galaxy to galaxy only if enough such massive stars have been formed in the parent galaxy. If, for instance, a dwarf galaxy failed to produce stars at least as massive as about 20 $M_\odot$, the brightest red stars will be fainter than expected, and, hence, the distance will be overestimated. On the other hand, the existence of an upper limit to the bolometric magnitude of red supergiants requires a special stellar evolution model, namely, the *very* massive (blue) stars ($\gtrsim 30\ M_\odot$) do not evolve into red supergiants but are directly turned into Wolf-Rayet stars, thus becoming supernovae (type II) progenitors.

The supernovae are unfortunately short-lived, transient phenomena. Normally, galaxies we are studying do not please us with the production of a supernova explosion which would help us to derive the parameters for the system. The Cepheids are certainly the best we have to probe the galaxies within about 10 Mpc, not the least so because corrections to data are only minimum. With the introduction of CCD cameras in astronomy we have a tool to reach the required faint limits of $B \approx 26^m$ with ground-based telescopes like e.g. the 3.6 m or even the new 2.2 m at La Silla. Such future observations will ultimately prove or disprove the applicability of all other distance indicators. In the meantime we have to rely on a variety of "rods". Here I recommend (because HI 21 cm line studies are among my prime interests) the Tully-Fisher relation. And this is, at the present state of the art, in favour of the Sandage-Tammann distance scale leading to a Hubble constant of about 50 km/s/Mpc or perhaps a bit higher, but most probably not more than 75 km/s/Mpc.

Now I present the context for the—apparently decoupled—two previous parts of this contribution. If we now apply those four distance indicators to the galaxies in the environment of the Local Group we get the impression that the concept of a local *group* probably can no longer be maintained. Rather we may be embedded in a local *filament* which can be traced at least from the Sculptor group to the "Local Group" and further to the M 81 group, i.e. over more than 5 Mpc. So only a few years after the start of the discussion of filamentary structure in the universe at large we begin to discover this structure in the galactic neighbourhood and in the local supercluster.

Concluding one may say that the routes of reasoning of G. deVaucouleurs and of A. Sandage and G. A. Tammann have both many pros, but perhaps also as many cons. What I wish to say is that one should not blindly trust every statistical application of a *new* distance indicator. This may well imply that the next who writes on the topic of extragalactic distances will show that what I have written here cannot be trusted! As a preventive excuse I may mention that I have written this short contribution while I was observing at La Silla with the ESO 1.5 m telescope where the necessary guiding was interfering.

Detailed references to the data used for Fig. 2 can be obtained from the author.

Multiple Stars—a Nuisance to the Observers

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Already in popular textbooks you can read that double stars are frequent phenomena in the Milky Way. In the first instance this concerns the visual double stars that every one can admire through the telescope. They constitute a considerable fraction of the total stellar content, with a certain statistical frequency dependence upon spectral type and luminosity class that may partly be physically significant but, to an overwhelming extent, is conditioned by selection effects.

If we add the spectroscopic binaries, we increase the number by at least an order of magnitude and if we take into account also the higher multiples, we may find that the number of stars in multiple systems exceeds the number of single stars.

Multiple stars of any type are generally revealed more or less by accident. This means that we have to count upon a considerable number of undetected multiple systems. It is a well-known fact that visual binaries with equal components are much easier to discover than those with a magnitude difference of say 2^m or more. A statistical survey of available double star catalogues will show a significant overrepresentation of components with rather equal temperature, and it is obvious that this effect is predominantly an observational bias. For most studies, however, the visual binaries are harmless objects which do not constitute any real menace to your projects, so we leave them in peace here. Sometimes, of course, you also encounter some sort of semi-visual binaries, i.e. systems which are classified as single objects in the CD and HD catalogues but which can be resolved in the telescope under particularly good seeing conditions. Such objects may be harassing enough to observe, especially if you try to get a spectrum and cannot be convinced that you have one and the same component on the slit all the time. If the seeing disk is larger than the angular separation of the components, their relative contribution to the resultant spectrum is highly dependent upon the centring on the slit. Personally I suspect that

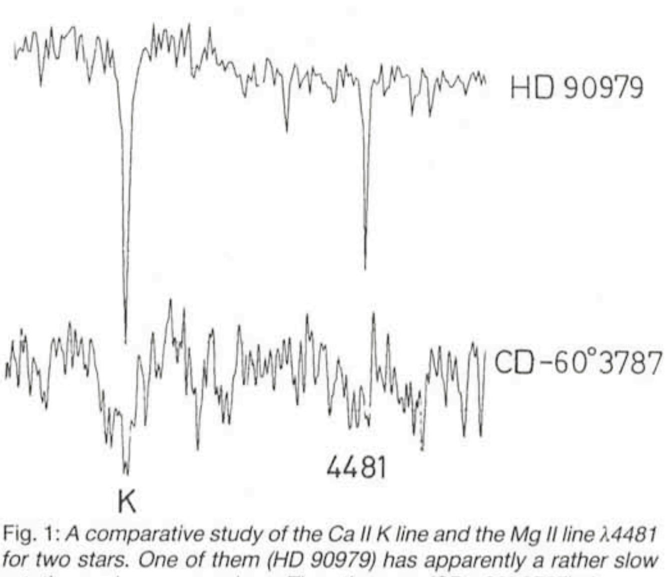

Fig. 1: *A comparative study of the Ca II K line and the Mg II line λ4481 for two stars. One of them (HD 90979) has apparently a rather slow rotation and no companions. The other one (CD −60° 3787) shows a very complicated spectrum due to multiplicity.*

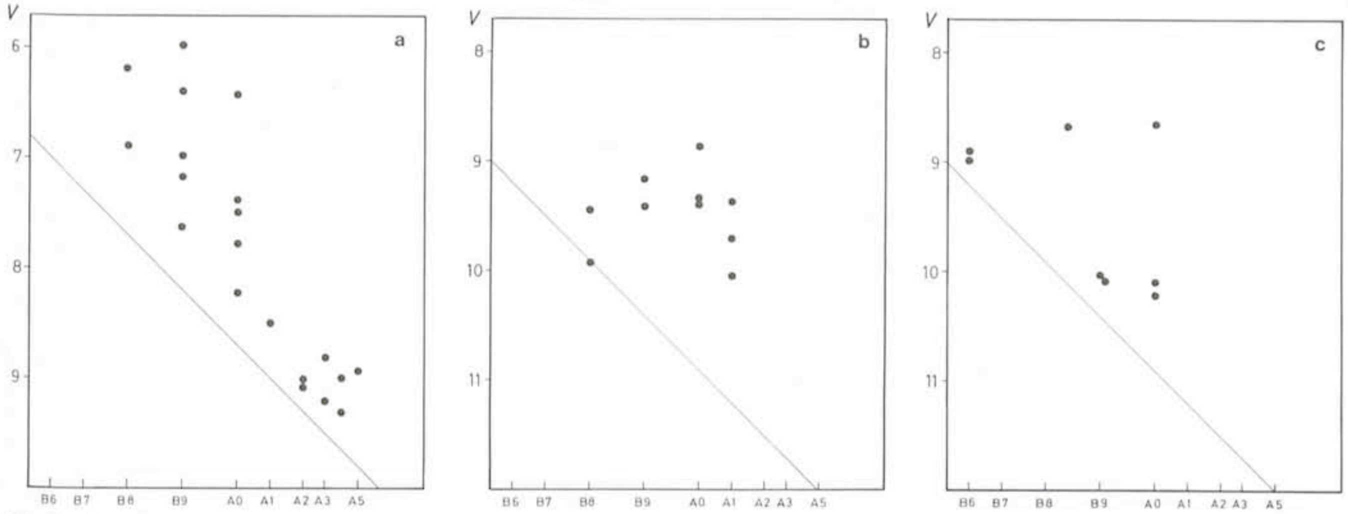

Fig. 2: *The relevant part of an HR diagram for three clusterings in the southern Milky Way. (a) NGC 6475; (b) a loose clustering around* $\alpha = 10^h\,27^m\!.3$, $\delta = -56^\circ\,32'$ *(1950; (c) a loose clustering around* $\alpha = 12^h\,05^m\!.1$, $\delta = -60^\circ\,33'$ *(1950). The scale on the spectral type axis is adjusted to give a reasonably linear main sequence in this region (the inclination indicated by the thin line).*

individual tendencies on this point might explain some discordant results of spectral classification.

If we then turn to the true spectroscopic binaries, the correlation between on the one hand the similarity in spectral type and on the other hand the probability of detection, is not as strong as in the case of the visual binaries. If the stars are very similar in spectral type you will find no unexpected lines in the spectrum which make it "composite". You can only see if the lines are doubled by Doppler effect but, for spectra of reasonable dispersion, the projected difference in radial velocity has to be rather great and this difference in turn is mainly a function of the inclination of the orbit and the orbital positions of the components. For many binaries it is only during very short time intervals that there is a chance to reveal the duplicity in this way. Furthermore, the displacement of the line components is seldom large enough to be detected by visual inspection of the plates. They have to be photometrically scanned (see Fig. 1). In any case it is advisable to keep in mind that a spectrum with doubled lines will always reveal at least a double star whilst a single-line spectrum gives no direct guarantee of a solitary star.

In cases of more or less pronounced difference between the components we meet another type of difficulties. Difference in spectral type also means a difference in brightness and hence in relative contribution to the composite spectrum. Between, say, a B 8 and an A 8 star the intensity ratio is of the order of 6 to 7 and, in low dispersion, a spectrum formed by such components will look pretty much like a typical B 8 spectrum. In somewhat higher dispersion the superficial appearance may be that of a metallic line A star, etc.

The stars which I have been personally dealing with during the last years are confined to the rather narrow spectral type range B 5 to A 5 with a pronounced concentration around A 0, and the main problem encountered has been connected with plotting of HR diagrams for open clusters. Within the framework of the project in question one has, *inter alia,* to find out if some stars are probable members of a certain cluster or if an apparent clustering of stars really forms a loose but physical open cluster of any kind. The most handy way then is to plot the magnitudes against the spectral type or another suitable temperature parameter. Stars difining reasonably well a main sequence—or at least a common pattern—are the ones to be regarded as good candidates for cluster membership. For some clusters one may get a very nice HR diagram in that way. In many cases, however, one will find a rather poor grouping around the expected sequence and in those cases it is difficult or even impossible to use the diagram for establishing the physical reality of the suspected cluster and for discrimination of cluster members from field stars. The main reason for such accidents is a predominating occurrence of unresolved multiple stars in the population. The typical member is no more a solitary object with a unique spectral type and absolute magnitude. Fig. 2 shows three examples;

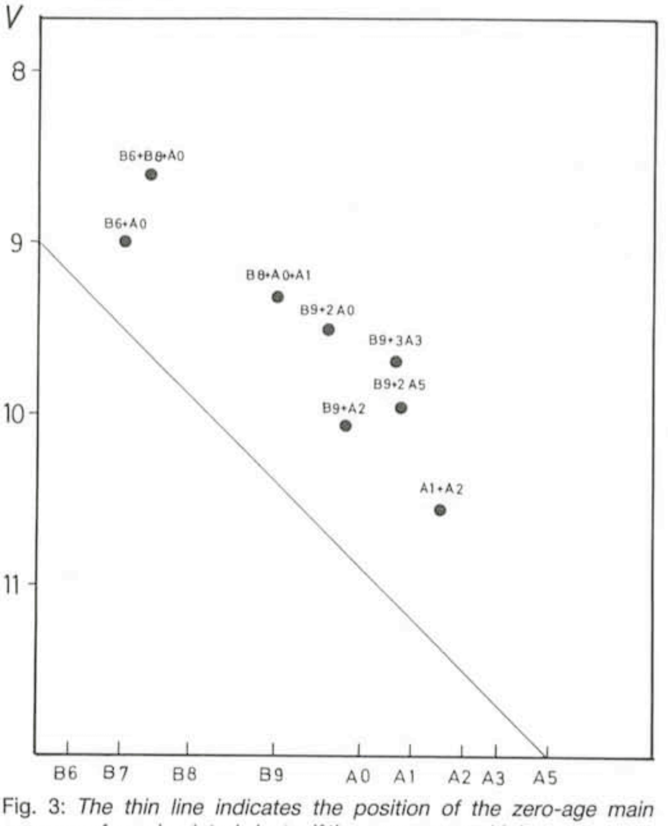

Fig. 3: *The thin line indicates the position of the zero-age main sequence for a simulated cluster if there were no multiple stars among the members. The points show the approximate places where you would find them if the objects were composed by combinations of various types of stars.*

the well-known cluster M 7 (NGC 6475) and two rather loose clusterings in the Milky Way, the physical reality of which is almost certain although not convincingly confirmed. Attempts have been made to plot the relevant part of the HR diagram on a format where the main sequence should be a straight line. The inclination of this line is indicated in the figures. In no case the connection to the line seems to be particularly nice. Before blaming the multiplicity we have to make a few reservations, of course. Firstly, it is reasonable to expect a few background or foreground stars in the material. Secondly, the main sequence has a finite width.

However, as the multiplicity of a number of stars has been revealed by their spectra, obtained with the coudé spectrograph of the 1.5 m ESO telescope (dispersion 20 Å/mm) and at the Observatoire de Haute-Provence (10 Å/mm), we know that it is there and that it must contribute to the observed scatter. The question then is: Are there no possibilities to correct for the effect of duplicity? Superficially it sounds relatively simple but in practice it is generally not simple at all. In the idealized case, when a system is composed by two identical stars, you just add 0.75 to the observed V value. The problem is that it is never possible to be sure that there are really two identical stars. In most cases one has only access to the colours and any observed total colour of a system can be synthesized by a multitude of combinations of various stars. Also in cases when spectra are available, there is no unique component composition behind every observed spectrum and, in addition, the result of the classification of a composite spectrum is highly dependent on the actual classification criteria. The most crucial fact is that the revealed number of components is only a lower limit so that the true number, as mentioned above, may be considerably larger. Fig. 3 shows a simulated case of a colour-magnitude diagram on the same format as the diagrams in Fig. 2 in which a number of multiple stars with typical component combinations are illustrated.

The study of double stars, triple stars, quadruple stars or stars of still higher degree of multiplicity is thrilling and interesting indeed, but when they appear with too high a frequency in stellar clusters, they definitely constitute a nuisance to the observer.

Exciting Stars in the Omega Nebula

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Every astronomer has his favourite object, which he studies sometimes throughout many years. Whenever he gets a few nights for observation he looks at "his" object to see how it is doing. My favourite object is the Omega Nebula, also known as M 17.

M 17 is one of the brightest H II regions in our galaxy. Numerous observations at radio and infrared wavelengths have shown that this complex, associated with a huge molecular cloud, is a site of recent star formation. Due to the large amount of interstellar dust within and around the H II region the exciting stars responsible for the visible nebula could not be identified uniquely. In 1976, I started an investigation of the stellar content of M 17 by photometry of more than 100 stars to be seen within the area marked in Fig. 1. This photometry—which was performed at the Calar Alto Observatory in the wavelength range from 0.3 to 0.9 μm—revealed that a large number of young massive O and B type stars have been born within the region. Some of the objects, however, had energy distributions which could not originate from "normal" stars: according to the spectral type derived from the UBV data, i.e. from 0.3–0.55 μm, the measured brightness at R (0.7 μm) and I (0.9 μm) considerably exceeded the expected values. These IR excesses could be produced either by circumstellar dust shells or by gaseous envelopes. To investigate this problem (and some others) I applied—for the first time—for some nights at the ESO 1 m telescope on La Silla with the IR photometer. Fortunately, some time was allocated to my programme, and I had the opportunity to observe M 17 for about 7 hours per night, as it passed through the zenith. For a northern hemisphere observer, who is used to observe the Omega Nebula for only 2 or 3 hours and even then always close to the horizon, this is an unforgettable event. Most of my favourite stars were too faint to be seen in the eyepiece of the IR photometer, but with the help of the experienced night assistant R. Vega, I was able to pick them up at 2.2 μm by scanning the telescope around the expected positions and by watching the equipment to show a signal. Due to excellent weather in August 1981 I could measure all of my interesting objects from 1.2 to 3.5 μm. Surprisingly, the objects became still brighter with increasing wavelength, i.e. the IR excesses already present at R and I got even larger: The faint optical stars had turned into strong IR sources.

Back in Germany, I tried to understand the new observations and fitted black-body curves to the energy distributions between 1.2 and 3.5 μm. The result was that only extremely

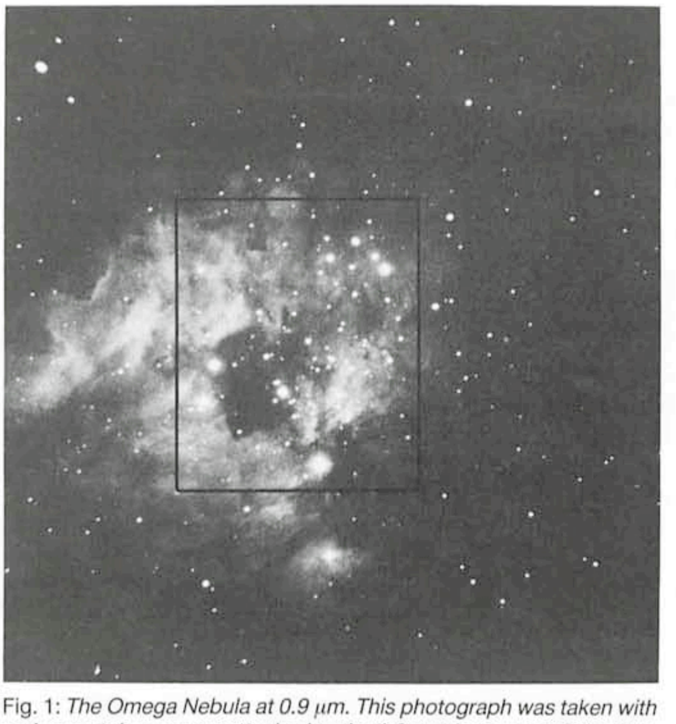

Fig. 1: *The Omega Nebula at 0.9 μm. This photograph was taken with an image-tube camera attached to the 1.2 m telescope at Calar Alto. North is at the top, east to the left. Inside the marked area many young stars are embedded in the dust.*