LETTERS TO NATURE

Ton 155 and 156: a Double Quasar?

Janes and Lynds[1] have shown that Ton 156 is a quasar, although they were unable to determine a satisfactory redshift. My spectroscopic observations, made with the Mauna Kea 224 cm telescope, have shown that Ton 155, located at about 35″ arc north preceding Ton 156, is also a quasar and have allowed redshifts to be determined for both objects.

The spectrograms were obtained with a 'Varo' single-stage image intensifier and covered the wavelength range from 4000 Å (the limit of transmission of the fibre-optic faceplate of the image intensifier) to 7600 Å at a dispersion of 190 Å mm^{-1}. The most prominent feature in the spectrum of Ton 156 is an emission line at 4339 Å, in fair agreement with the value of 4333 Å reported by Janes and Lynds. Also present is a broad, moderately strong, emission line at 7524 Å. The identification of these lines with Mg II λ2798 and Hβ, respectively, gives a redshift $z=0.549$. The weaker lines listed by Janes and Lynds are not apparent on my plates, but their lines at 4410 Å and 4936 Å are close to the expected positions of [A IV] λ2854 and He II λ3203. The spectrum of Ton 155 shows broad, moderately strong, emission lines at 4187 Å and 5160 Å, which can be interpreted as C IV λ1549 and [C III] λ1909 at a redshift $z=1.703$.

The Tonantzintla list gives $m_{pg}=16.6$ for Ton 155 and $m_{pg}=16.0$ for Ton 156, but systematic corrections to the Tonantzintla magnitude scale[2] change these values to 16.9 and 16.4, respectively. Assuming that the whole-sky number of quasars brighter than magnitude 17 is approximately 5,000 (this value is a liberal extrapolation based on recent studies[3–5]) and that these quasars are randomly distributed, the *a priori* probability that any particular one of these quasars should be located within 1′ arc of another is $\sim 10^{-4}$. Thus, the probability that a quasar brighter than magnitude 17 should be found within 1′ arc of one of the sixty previously known quasars brighter than magnitude 17 is $\sim 6\times 10^{-3}$.

The present observations clearly give additional support to the position that not all quasar redshifts are cosmological. It would be of value to obtain spectra of some of the other close pairs that occur in the Tonantzintla lists.

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VRS for VRO

A curious coincidence in terminology, which may lead to confusion, has arisen in connexion with some cosmic radio sources. It is apparently becoming customary to refer to these sources by the general designation VRO, for "variable radio object".

By coincidence, the prototype of such sources was first catalogued[1] in the survey of the Vermilion River Observatory (VRO) and was named VRO 42.22.01. It has since been identified with the star BL Lacertae and has been extensively observed. Another such source, number 20.08.01 in the Vermilion River Observatory catalogue, has also been identified as a variable optical object[2]. Wenzel[3] has referred to this source as "20.08.01 Cancri" and as "VRO 20.08.01", apparently intending the VRO to stand for "variable radio object". It might better be designated as H0852+20, the designation made in the catalogue in which it was first listed[4].

Both VRO 42.22.01 and VRO 20.08.01 are designations from the Vermilion River Observatory catalogue, containing thousands of sources with similar names, very few of which are known to be "variable radio objects". I suggest that VRS, for "variable radio source", would be a better designation for this class of object.

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Evidence for the Hydrodynamic Character of Microturbulence

Worrall and Wilson[1] have questioned the validity of determinations of the chemical composition of stellar atmospheres from observations of absorption lines in stellar spectra. Their main argument is directed against the concept of "microturbulence", which has been used for several decades to explain the high level of the flat part of the curve of growth. It was first introduced by Struve and Elvey[2] to account for the apparent systematic variation of the abundances with the total amount of absorption (equivalent width) of the spectral lines from which they are derived. Microturbulence is thought of as a statistical velocity field in the stellar atmosphere, with moving gas elements whose optical depths for the photons to be absorbed are smaller than unity. This small scale velocity field widens the frequency interval for the absorption of photons; this has no influence on the strength of the weak lines, but the equivalent width of saturated lines is increased. In the curve of growth, which represents the relation between the effective number of absorbing particles in the stellar atmosphere and the equivalent width of the absorption line, the flat part of the saturated lines is lifted. Thermal motion of the absorbing atoms frequently fails to account for the level of the flat part of the curve of growth; according to Worrall and Wilson this is the only independent evidence for the existence of small scale turbulent motion in stellar atmospheres. Their statements on this point are strong: " . . . There are no independent observations even

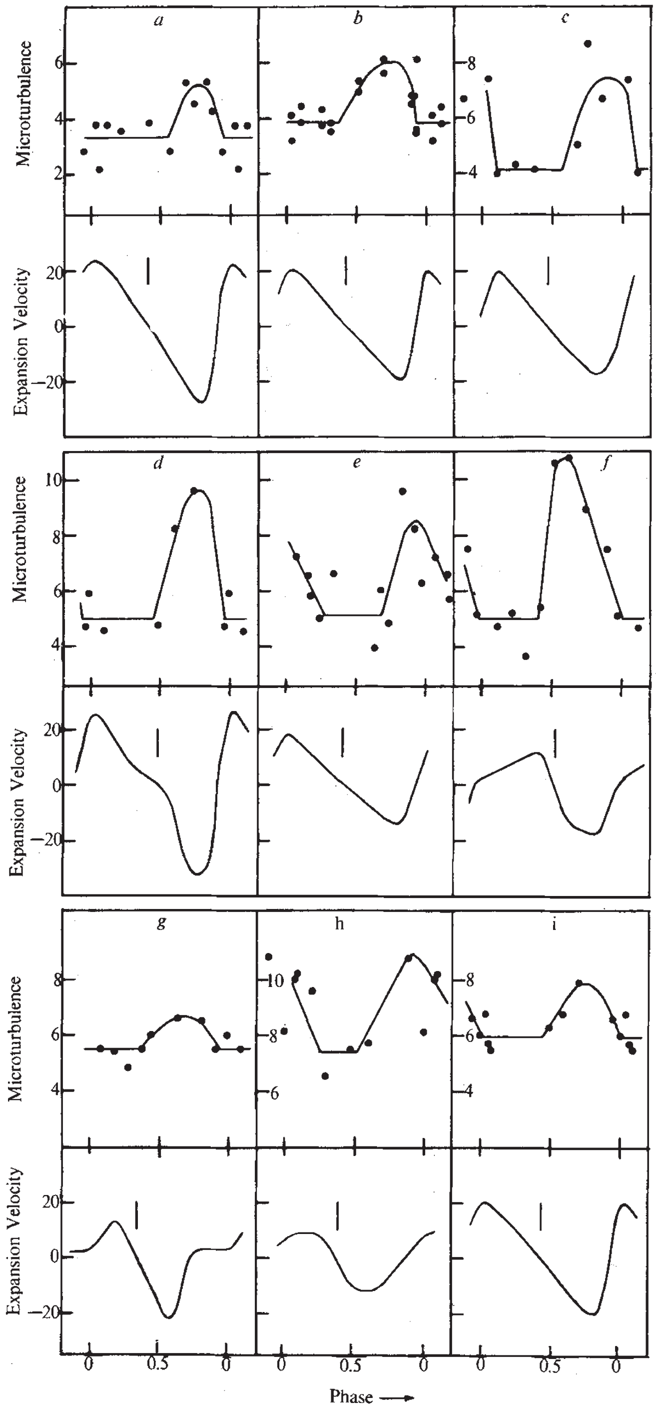

Fig. 1 The variation of the microturbulence and the radial pulsation velocity (in km s^{-1}) for a number of classical cepheids. The small vertical line in the radial velocity diagram denotes the phase of largest expansion. *a*, RT Aur; *b*, δ Cep; *c*, U Sgr; *d*, η Aql; *e*, χ Pau; *f*, S Nor; *g*, β Dor; *h*, γ Oph; *i*, ι Car.

suggesting that such small-scale, non-thermal motion exists, much less defining its amplitude. . . . ". Worrall and Wilson suggest that the level of the flat part of the curve of growth is determined by non-local thermodynamic equilibrium (LTE) effects. I show here that other observations, supporting the concept of microturbulence, do exist.

In all abundance analyses from high dispersion spectra of cepheid variables, which have been reported[3-14], a common feature is that microturbulence is variable with phase. Furthermore, in all stars considered, this variation of the microturbulence is strongly correlated with the variation of the radial pulsation velocity. The variation with time of these properties is shown in Fig. 1. A general feature is that the microturbulence is increasing after the star has reached its largest radius and the atmosphere is falling downward. The phase of largest expansion is indicated by a small vertical line in Fig. 1. A straightforward interpretation of this correlation is that in the falling atmosphere there is a transfer of turbulent kinetic energy from large scale to small scale motion, similar to the case of homogeneous turbulence[15]. A correlation between irregular changes in microturbulence and radial velocity has also been found in some "non-variable" supergiants[16]. The influence of departures from LTE on the level of the flat part of the curve of growth would be expected to depend on the electron pressure, since collision with electrons is the most important mechanism yielding LTE. A comparison of the variation of electron pressure with that of microturbulence shows that there are difficulties with an explanation in terms of non-LTE processes only. Often the electron pressure hardly changes, whereas the microturbulence does so, and the other way around.

These observations strongly suggest that the microturbulence as used in coarse curve of growth analyses is, at least in part, a real hydrodynamic effect.

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Probable Late Ordovician Glacial Marine Sediments from Northern Sierra Leone

THE Saionia Scarp Series[1,2], here redesignated, in accordance with international nomenclature, the Saionia Scarp Group, is a marine sequence of so far undated rocks[1-3], occurring in northern Sierra Leone (Fig. 1). The group has the characteristics of a glacial deposit. The sediments crop out in vertical cliffs which border a high plateau that rises to 800 metres and extends northwards into Guinea. They form a horizontal sequence which lies unconformably on the folded late Precambrian Rokel River Group in the west, and oversteps on to the Kenema Assemblage (Precambrian granitic basement) in the east. The age of the Saionia Scarp Group is not known but it is considered to be the lateral equivalent of the "Gres Siliceux Horizontaux" which occurs in adjacent parts of Guinea[2-4] These horizontal sandstones are taken as being Ordovician in age since they are conformably overlain by middle Silurian graptolitic shales at Télimélé in Guinea[5,6].