LETTERS TO THE EDITOR

ASTROPHYSICS

Deficiency of Metals in Population II Stars

PROF. S. BASHKIN's recent reply¹ to our communication² contains a number of errors.

(1) Bashkin states that Wallerstein *et al.*³ did not take into account Rayleigh scattering in their analysis of metal-poor giants. However, they did specifically include Rayleigh scattering as a source of opacity as shown in their Table 9 and accompanying discussion.

(2) Bashkin remarks that among the metal-poor stars that we have discussed, only HD 165195 is not a halo star. We reiterate that HD 122563 and HD 140283 have motions perpendicular to the galactic plane of 19 and 16 km/sec, respectively. Such velocities can carry these stars to no more than 250 parsecs from the galactic plane. They cannot, therefore, be called halo objects.

(3) Bashkin refers to Traving's work on Barnard's star⁴. Lest the reader think that Traving has obtained the He/H ratio for the *M* dwarf BD + 4° 3561, which is generally known as Barnard's star, we point out that Traving analysed 'Barnard 29', a B2 star in the globular cluster M13.

(4) Bashkin refers to the "normal He/H ratio in population II stars". We note that the only population II stars in which the He/H ratio has been obtained are the two peculiar objects discussed by Traving, and Bashkin himself questions the relevance of Traving's *B* stars to general galactic problems because they may be young objects. No He/H ratio has been obtained for any of the old, metal-poor dwarfs or giants. We feel that reference to the He/H ratio in population II stars as if it were a fact merely covers up an enormous gap in our knowledge of galactic and stellar evolution.

(5) Finally, we wish to agree with Bashkin regarding the need for more and improved abundance data, especially the ratio of O/H, in population II stars. However, the data that are now available, scanty and inaccurate as some may judge them to be, are in complete disagreement with Bashkin's original suggestion⁵.

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¹ Bashkin, S., *Nature*, **200**, 1082 (1963).

² Wallerstein, G., and Burbidge, E. M., *Nature*, **200**, 1081 (1963).

³ Wallerstein, G., Greenstein, J. L., Parker, R., Helfer, H. L., and Aller, L. H., *Astrophys. J.*, **137**, 280 (1963).

⁴ Traving, G., *Astrophys. J.*, **135**, 438 (1962).

⁵ Bashkin, S., *Nature*, **197**, 1091 (1963).

Profile of the $H\beta$ Line in the Spectrum of Zodiacal Light

As a result of the observations of Blackwell and Ingham¹ it is now believed that the zodiacal light is almost entirely due to the scattering of sunlight by dust particles concentrated into the plane of the solar system. Because of the orbital velocities of these dust particles, the Fraunhofer absorption lines in the spectrum of zodiacal light should show Doppler shifts. During June–August of 1962, observations were made at Chacaltaya (long. 68° 08' W., lat. 16° 21' S., alt. 5.5 km) to measure this Doppler shift for the $H\beta$ Fraunhofer line, using a specially constructed, high-luminosity, photoelectric spectrometer. The spectro-

meter was of the Ebert type, with the resolving power or luminosity increased by using it in series with a large Fabry–Perot etalon². The addition of the etalon improved the performance of the system by a factor of 10 over the best that could be realized from a conventional spectrometer design. The etalon plates were of 90 mm useful diameter, polished by Hilger and Watts, Ltd., so that the gap was uniform to better than $\lambda/50$ at 5461 Å, and coated by Grubb Parsons with seven-layer dielectric reflecting coatings. The etalon was enclosed in a pressure vessel which could be filled to a controlled pressure with propane gas. This made it possible to vary the refractive index in the gap between the etalon plates and so change the order of interference, and hence the wave-length, passed by the interferometer. The Fabry–Perot fringes were focused by a plano-convex lens of focal length 47.5 cm on the entry slit of the Ebert spectrometer, which utilized mirrors of focal length 68 cm and a 128 mm by 208 mm plane grating (Bausch and Lomb No. 33–53–27–57) worked in fifth order. The grating of the spectrometer was imaged through the exit slit on to a photomultiplier (E.M.I. 6256 S), especially selected for low dark noise, which fed a pulse counting system with digital output.

The instrument was installed in a hut on the south summit of Chacaltaya and was fed with zodiacal light by a mirror mounted on a brick pillar outside the hut. From this site it was possible to observe both the morning and the evening zodiacal light.

The spectrometer slits were set to give an entrance slit width of 8 Å and an exit slit width of 10 Å. Thus the pass band of the spectrometer was trapezoidal, 26 Å wide at the base and 10 Å wide at the peak. The etalon spacing was chosen to give a spectral range of 30 Å with a finesse of about 25, that is, to give an instrumental profile approximately 1.2 Å wide. The entrance slit had a width of 6 mm and a length of 20 mm, accepting light from a region of the sky $2.5^\circ \times 0.75^\circ$. With solid carbon dioxide manufactured on the spot, the photomultiplier was cooled to a temperature of -40° C. Under optimum conditions the dark counting rate of the photomultiplier was 5 c.p.s., two of which were probably due to cosmic ray events in the glass envelope. The flux from the night sky alone at $H\beta$ yielded a rate of about 4 c.p.s., while the zodiacal light at an elongation of 40° gave an additional flux of 5 c.p.s. Allowing for instrumental losses, this corresponds to 4×10^8 photons cm^{-2} sterad^{-1} sec^{-1} $\text{\AA}^{-1}$. Because of the low flux rates the following procedure was adopted for all our observations: a scan was made of the $H\beta$ line from a low-pressure hydrogen lamp to determine the propane pressure corresponding to the wave-length of $H\beta$. At this pressure a count was taken over a period of two minutes of the photon flux from the zodiacal light and night sky. A dark count was then taken over an equal time period. The propane pressure was then changed by 27 cm mercury (corresponding to a shift of 1.5 Å) and both dark and zodiacal light counts were repeated. The line profile was established by observing at 7 points, at intervals of 1.5 Å, the points sometimes being observed in a random order so as to avoid systematic effects from such influences as changes of light level.

In addition to the zodiacal light observations, spectra were taken of the light from the night sky only, at a similar zenith angle. These usually showed a flat continuum, but on isolated occasions $H\beta$ appeared in emission. One of these scans was identified with the Orion spur, and we conclude that this emission was due to hydrogen in the galactic plane. Owing to bad weather and