sensory processing (for example, the centre-surround organization of retinal ganglion cells), but it would affect whatever parameters are laid out along the surface coordinates of a particular cortical area. This kind of hypothesis can be tested when the analytical approaches now being applied succesfully in area 17 are extended to other parts of the cerebral cortex. ☐

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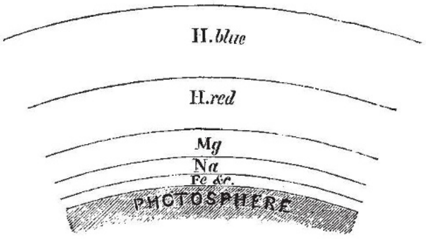
100 years ago

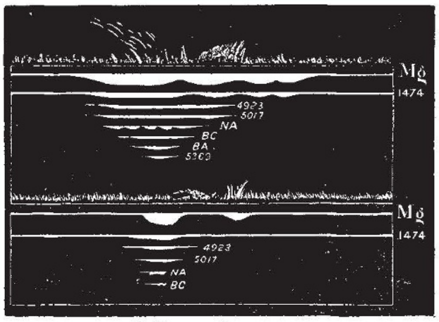
THE SUN AND STARS

The Chromosphere

In what has gone before we have been chiefly occupied with a discussion of the various chemical materials which we can trace in those cavities in the photosphere which we call spots. We have now to begin the consideration of the chemical materials which can be traced in that solar envelope which lies immediately over the photosphere, I mean the chromosphere: so that eventually we may endeavour to make a comparison between the chemical materials in the spots and in the chromosphere, which are supposed to lie, and which in fact really do lie, at about the same height in the solar atmosphere, with, however, the enormous difference that we know the spots are caused by the descent of materials coming down from above, and we do not know at present that that is true with regard to the substances in the chromosphere.



Early hypothesis of the arrangement of materials in the Sun's atmosphere. H = hydrogen; Mg = Magnesium; Na = sodium; Fe, & c. = iron and the other elements of high atomic weight.



Welling up of vapours

Now, the chromosphere we will take roughly, as it varies in height from year to year, and from latitude to latitude, to be between 5000 and 10,000 miles high. It is not only bright at the bottom — so bright, very often, that in eclipses, when the bottom is seen, observers imagine that the sun has reappeared — but it is exquisitely coloured at the top, and colours very often being scarlet, crimson, green, yellow, and so on. As ordinarily observed, the simple chromosphere varies very considerably.

From *Nature* **33** 499, 25 March 1886.

Low-luminosity stars

How no(w) brown dwarfs?

from Virginia Trimble

WHOLE careers and industries are built on extremes — the highest jump, the oldest fossil, the fastest horse. Thus it is perhaps not surprising that astronomers should, now and again, ask themselves which is the smallest star and does it differ significantly from the largest planet? The current best answers are van Biesbroeck 8B (vB8B) and yes, according to speakers at a workshop* last autumn.

The difference between stars and planets is at least as much in how the objects form as in their present energy sources, and vB8B falls cleanly in the 'star' class, although contraction may be contributing as much to its luminosity as nuclear reactions do. I shall return shortly to the third big question addressed at the workshop: are there enough faint stars to affect estimates of the local mass density (one aspect of the widespread 'missing mass' problem)? To this, the democratically chosen answer was a resounding 'maybe', but the situation looks a good deal more promising for small stars than it did a year or two ago.

David C. Black (NASA/Ames) drew a sharp line between small stellar companions and planets[1]. Stars form by fragmentation of a gas cloud without significant dissipation or chemical fractionation. Planets result when dissipation produces a disk around a single proto-star, within which bodies condense whose chemical composition and mass depend on distance from the centre of the disk. Alan P. Boss (Carnegie Institution, Washington) provided confirming evidence for this distinction. He has followed numerically the collapse and fragmentation of gas clouds of varying temperature and rotation rate until the fragments are so small that thermal support lets them contract slowly into single stars rather than breaking up further. No fragments smaller than 0.02–0.05 $M_\odot$ (20–50 Jupiter masses, M_J) ever formed, requiring a separate origin for planet-sized bodies. Most of the effects neglected in the calculation will tend to raise the limiting mass slightly. Boss and Hans Zinnecker (Royal Observatory, Edinburgh) both noted the main exception. Less dust lowers the limit by contributing less capacity, leaving open the possibility of still smaller stars within the metal-poor first generation, some of which may linger in the halo of our Galaxy.

None of the smallest fragments will ever burn hydrogen. This requires a mass $M \geq$ 0.08 $M_\odot$ and provides the traditional definition of 'real' stars, presenting us with the problem of what to call the smaller objects. Jill Tarter (University of California at Berkeley) put forward a strong case for the continued use of the folk name 'brown dwarfs', on the grounds that objects whose emission spectra we cannot even roughly predict should properly be called by a name that is not, spectroscopically speaking, a colour.

Deciding whether there are enough brown dwarfs to contribute appreciable local mass density is much more difficult. The task has several pieces: (1) identifying faint-star candidates and making sure there are no systematic biases against detection; (2) acquisition of enough data (colours, distances) or accurate enough model atmospheres to determine absolute brightnesses or effective temperatures for the candidates; (3) converting these to masses; and (4) drawing plausible extrapolation curves without violating other known limits.

Identifying candidates is a struggle in itself, many projects yielding only upper limits. Bruce Campbell (Dominion Astrophysical Observatory, British Columbia) and Geoffrey Marcy (San Francisco State University) reported searches for variable stellar radial velocities that might reflect the gravitational influence of invisible companions. Both searches rediscovered known binaries, but the former ruled out companions bigger than 1–3 M_J with orbit periods less than 5 years for all half-dozen stars examined, and the latter excluded companions above 7–50 M_J with periods $\lesssim$ 1 year for all but one of 65 stars. The period limits are too short to tell us much about massive planets, but a possible class of brown-dwarf companions must be rare. Marcy's new find orbits Gliese 623 (CC 986) with a 2.1-year period and is probably 0.05–0.08 $M_\odot$. Curiously, Gliese 623 was already known, from astrometric and infrared studies, also to have a slightly more massive companion in a 3.7-year, non-coplanar orbit. An investigation of the stable lifetime of this system would be interesting.

Other non-detections include single brown dwarfs and companions to nearby white dwarfs in the Infrared Astronomy Satellite (IRAS) database reported by Frank J. Low (University of Arizona) and Harry L. Shipman (University of Delaware) and companions to nearby main sequence stars and white dwarfs in images recorded with the Infrared Telescope Facility (IRTF) by M.F. Skrutskie (Cornell University) and C. Krishna Kumar

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* 1985 George Mason workshop on Brown Dwarfs, held at the George Mason University, Fairfax, Virginia 22030, USA from 14–15 October 1985.

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