Classification of Stars

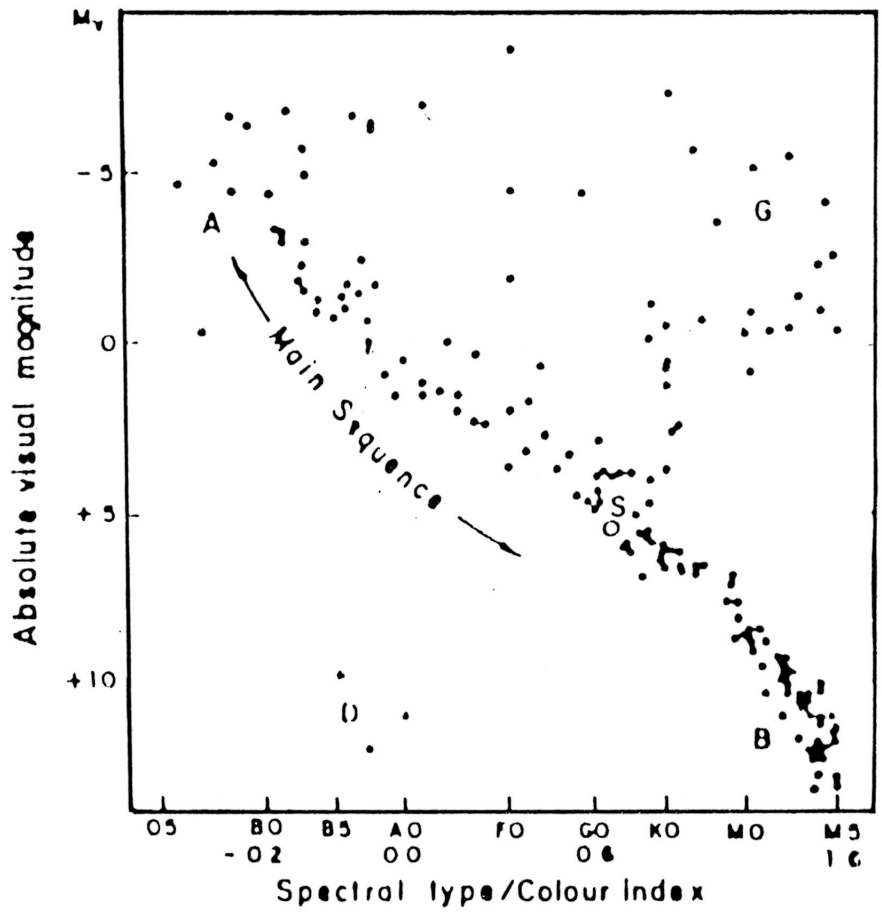
While the early decades of the twentieth century saw a dramatic rise in man's perception of the large scale structure of the universe, the steady but sure rise in his understanding of the physics of stars was no less important.

An important step was taken in this direction when two astronomers independently thought of plotting the stars on a graph, whose horizontal axis denoted their surface colours, ranging from blue to red, while the vertical axis denoted their luminosities. Such a diagram was first introduced by E. Hertsprung in 1911 followed by H.N. Russell in 1913. Commonly known as the Hertsprung Russell Diagram or simply the H-R Diagram, this graph plays a key role in the classification of stars and hence in the understanding of their internal structure and evolution.

The discovery of the black body radiation, and its quantum mechanical explanation by Max Planck at the turn of the century had set the relationship between colour of radiation, its wavelength and its temperature. A key astrophysical input to the problem of stellar structure came from the work of Meghnad Saha around 1919 when he showed how the state of ionisation of the atoms in stellar atmospheres is related to the ambient temperature in a thermodynamic equilibrium. Known as *Saha's Ionisation Equation*, this work provided the theoretical input towards determining the surface temperature of a star from its spectroscopy.

Thus, it followed that a blue star would have a higher surface temperature than a red star and hence in the H-R diagram it would lie to the left end whereas the red stars would lie to the right. Likewise the more luminous stars would lie in the upper part of the diagram compared to the less luminous ones. In the adjoining figure we see the so called *Main Sequence* stars distributed on the diagonal band from lower right to the upper left. Above the main sequence to the right lie the *Red Giants* while to the left below it lie the *White Dwarfs*. It was a challenge to the astrophysicists to explain why these stars are found distributed in this way.

Thus, the problem for the theoreticians was well posed: given the surface properties of a star like its temperature, luminosity and radius, find the details of its internal structure. The breakthrough in this direction came soon enough and will be described in the next parsecstone.



The H-R diagram. The end B of the main sequence has cooler and redder stars while the stars at end A are hotter and bluer. The Sun is at S. The part marked G is occupied by red giants and the part D by white dwarfs.