

## Stellar properties

There are no notes following each slide for this final section on stellar properties (See Koupelis & Kuhn chapter 12). The topic opens with a discussion of stellar motion. It seems to have been Edmund Halley, a contemporary of Newton we met earlier in the course, who first realised that some of the brightest stars in the sky (Sirius, Arcturus, Spica, Betelgeuse) had moved by at least the diameter of the Moon since Ptolemy's day. "*It is scarce credible*", he wrote, "*that the ancients could be deceived in so plain a matter, three observers confirming each other.*" The concept that the stars are 'fixed' had come down through the millennia and would take a long time to disappear. I'm not even sure it has. It's not as if stars are moving slowly, for typical speeds are tens of km per second, but the enormous distance that stars are away from us make the observable motion tiny. Hence it takes a long time to notice it, or one needs exceptionally high precision measurements of stellar coordinates. Yet another idea of ancient astronomy has had to be pitched. On a timescale appropriate to stellar evolution, the stars are buzzing around like a cloud of mosquitos.

The section goes on to introduce a key concept that is relevant to all the stars we see and also, as it turns out, to stellar evolution: the Hertzsprung-Russell diagram, a plot of luminosity versus temperature. Among the uses of this diagram are a means of determining the distance of stars that are beyond the range of parallax measurements. The plot clarifies that stars can be classified by names that reflect their evolutionary history. The most important variable determining the life of a star turns out to be simply its mass.

Winding up the thread of determining stellar distance, the value of a 'standard candle' is introduced with the example of one of the most important standard candles, Cepheid variable stars. These allow the distance scale to be extended from parallax measurements to around 50 million light years.

### *Final reflection*

I'll leave you with a final reflection. If you could go back in time and speak to a leading intellectual in this country who was alive two hundred years ago, what achievements of today would he find most astonishing? If you showed him 21<sup>st</sup> century Nobel prize winning literature, he might be amazed at the subject matter but probably not at the literature itself. I suspect he wouldn't be that impressed at modern painting, sculpture, poetry or music, though he would certainly acknowledge that they belong to a different era than his own. Descriptions of airplanes, TV and modern computers would astonish him and the knowledge that such things are possible would deeply impress.

What would change his view of life would be a description of what we know in modern astronomy: what we now know about the planets as other worlds, totally different from anything he or his contemporaries imagined; what stars actually are, what they are made of and how they are born, evolve and die over a timescale that he would consider unimaginable; what we know about the extent of the universe and our picture of how galaxies fill the universe on a large scale. He would scarcely credit that mankind has gone to the Moon, explored a tiny bit of it and brought back moon rocks to prove it; that spacecraft have gone to every planet in the solar system (including Neptune and Pluto, neither of which he would know about) and sent us back pictures of places so different from the Earth that they are beyond his wildest dreams. If you were button-holed by such a person you would be detained for days and interrogated about almost the whole content of this course, and more besides.

Astronomy has advanced astonishingly, not just in 200 years but in my lifetime and even in yours. What is reported today in a matter of fact way as weekly news would have seemed scarcely believable even 50 years ago.

One fact that will astonish you as an adult - it has certainly astonished me - is how reluctant many of your contemporaries are to change their views in adult life, to absorb new knowledge and change their ways of looking at the world. I'm referring here to all aspects of society, political, religious, artistic, social and almost any aspect you can think of. Studying such a rapidly changing subject as astronomy is a wonderful way of acquiring a flexible mind that will benefit you in every walk of life. I hope you have enjoyed our course and will keep reading about developments in astronomy.

*JSR*