New Cambridge University star catalogue 'most accurate ever'

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For thousands of years, people all over the world have gazed at the night sky and wondered just how far they would have to travel to reach the stars.

After tomorrow, scientists will be better able than ever to answer the age-old question, with the release of the most accurate guide to the distances between us and the heavens' far-flung diamonds.

A new catalogue of stars, the result of a decade's painstaking research at Cambridge University, is being published, giving the distances to almost 118,000 stellar bodies.

For astronomers, “Hipparcos – The New Reduction of the Raw Data” promises to open up a new chapter in the study of the age, size and properties of stars, helping them to tackle fundamental questions about the origins of the universe with greater precision than before.

The book has been compiled almost single-handedly by Dr Floor van Leeuwen at the University's Institute of Astronomy. In some cases, its contents are up to five times more accurate than the previous guide, offering scholars what in astronomical terms is the closest they can get to pinpoint accuracy.

Without that type of information, it would be much more difficult to compare the properties of stars or galaxies. Astronomers can only determine the physical properties of stars by comparing their luminosity

with their distance from the earth. Without an accurate measurement of distance, the star's true luminosity or size cannot be known.

Similarly, the distances to the stars are the first stepping stone in the process of inferring the distance to ever-more remote galaxies and quasars. Getting the first step as correct as possible is vital for the rest of astronomy, with implications for the scale of the Universe itself.

“Knowing the distances of stars is fundamental to everything in astronomy,” Dr van Leeuwen explained. “Without reliable distances, everything else is unreliable. This catalogue marks a huge improvement to the foundations on which we build the entire discipline. One way or another, everything else astronomers study depends on it.”

The original star catalogue was published in 1997 following the European Space Agency's Hipparcos satellite mission, and was described by some as a “quiet revolution” in the study of space. With its help, astronomers were able to recalculate both the date of the Big Bang, and the point at which the very first stars were formed.

The distances were calculated by measuring parallaxes – tiny shifts in the apparent position of stars against a further-flung background. Parallaxes are the same phenomenon we see when we hold a finger in front of our face and view it first with one eye, then the other. In the same way that the finger appears to change position against the background, so stars appear to change their position when viewed from different points on the earth's orbital path.

The Hipparcos satellite was launched into space to a point where, free of the Earth's atmosphere (which can blur the effect) it was able to provide a clear set of parallax measurements. Once they had this information, academics were able to calculate the distance to tens of thousands of stars.

But although it was a major breakthrough in star measurement, arguments raged over whether Hipparcos' data contained systematic errors. When clusters of stars were measured, apparent discrepancies emerged that left some uncomfortable as to its accuracy.

Dr van Leeuwen continued analysing the Hipparcos data in great detail. Eventually, he discovered that when Hipparcos passed behind the Earth, putting our planet between it and the Sun, the change in temperature was affecting the solar panels in such a way that the satellite was twisting. The shift was almost imperceptible – a few thousandths of a millimetre – but enough to affect the angle of the telescope and the measurements it was taking.

Once this problem had been diagnosed, Dr van Leeuwen was able to scan through the data for incidents where the panels might have shifted, factor in the changes, and recalculate the data. The work has taken 10 years, but the upshot is a catalogue with a much higher degree of accuracy than previously existed.

“The discovery of the problem with the satellite left me with no option but to recalculate the data,” Dr van Leeuwen added. “I knew that it could be done and I knew that the existing data could be significantly improved in all aspects, so I had no choice.

“It was an extremely painful process. You can spend a whole weekend examining one small part of the data and making the resultant corrections can take two weeks. But the result is that we now have a catalogue more accurate than ever before, and one in which we know that all the calculations work.”

Hipparcos, the New Reduction of the Raw Data, will be published on September 27th by Springer as Volume 350 in the Astrophysics and Space Science Library Series. It includes a general guide explaining how

the information can be used and how the reduction of the data was achieved.

Source: University of Cambridge

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