EM9619: The Globe and Mail, February 16, 1996, page A10

Study backs up illogical notion

Oldest stars seem to predate Big Bang

BY STEPHEN STRAUSS
Science Reporter

TORONTO – The proposition that the stars in the universe are older than the universe itself may be a logical impossibility, but it's one that just won't go away.

The issue first arose in 1994, when Canadian and U.S. astronomers reported that the age of the universe appeared to be between eight billion and 12 billion years, while other measures said the oldest stars clocked in at about 16 billion.

An article appearing today in the U.S. magazine *Science* adds more spice to a debate that one science publication's head line characterized as "a universe in conflict." Theoretical astrophysicists at the University of Toronto, Yale University and Case Western University in Cleveland have run a series of computer simulations over an eight-week period factoring in estimates of the ages of more than four million stars.

In the computer's considered opinion, there is a 95-per-cent chance that the birthdays of the stars and the universe do not jibe. According to the new report, there is only a one-in-20 chance that the oldest stars are about 12 billion years old, and a 50-per-cent chance that they are about 14.5 billion years old.

On the other hand, the most likely age of the universe, measured as the supposed time since the Big Bang, is now seen to be in the range of six billion to 10 billion.

"It is embarrassing that the star clusters are older than the universe," Case Western astrophysicist Lawrence Krause, co-author of the study, said of the incongruity.

The new paper is an attempt to factor in all the uncertainties that have gone into previous star-age estimates. The confusion arises because there are two measuring systems at work.

One system computes the age of stars by comparing their brightness, colour and other parameters with age values predicted by theories of how fast they are burning themselves out. Prof. Krause likens this to determining the distance a car has travelled by knowing its fuel efficiency and how many pit stops it has made.

Although the life cycle of stars had been determined before, individual measures were rife with various uncertainties. For instance, there are disagreements among astronomers about rates at which helium sinks toward the centre of a star while hydrogen rises to the surface. These affect the efficiencies of the atomic fusion processes that lead a star to burn up over billions of years.

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The greatest uncertainty – somewhere between 6 and 10 per cent – lies in the accuracy with which the distance to stars can be determined. To work, models must judge with extreme care the distance difference between relatively small objects that appear bright because they are close, and very bright objects that appear dim because they are far away.

To arrive at the study's age-of-the-universe prediction, Brian Chaboyer, a postdoctoral fellow at the U of T's Canadian Institute for Theoretical Astrophysics, did 1,000 computer runs on groups of stars found in nebular clusters – dense clumps of a million or so stars.

Various parameters were changed in the runs so the effects of many different uncertainties could be factored in, to produce a range of possible star ages.

Prof. Krause said that using the car-race analogy, this would be like trying to arrive at ranges of fuel efficiencies and pit-stop times that average out the differences between Hondas and Cadillacs.

Dr. Chaboyer said this means that modellers will have to take a much deeper look at the other way astronomers measure how old the universe is. This attempts to arrive at age by factoring in the expansion rate of the universe – the so-called Hubble constant – since the Big Bang.

In essence, if you can tell how far away stars are and the rate at which they are moving away from one another, you can determine how long they have been around.

Prof. Krause likened this to knowing how many laps cars have gone and their average speed.

Unfortunately, the rate at which gravity is slowing the rate of expansion of the universe is a matter of considerable disagreement. Measures taken by the Hubble space telescope and the Canada-France-Hawaii telescope in 1994 suggested changes in expansion speeds that produce the universe-too-young-for-its-stars scenario.

To resolve the issue, some astronomers are contemplating a return to an old idea of Einstein's. This argues that there is a countervailing force – a cosmological constant – that keeps gravity from reducing the speed at which galaxies are moving away from one another.

Others have floated an even more radical notion. All the difficulties can be resolved if, for reasons nobody understands, the universe's rate of expansion is actually speeding up.

REFERENCE: Chaboyer, B., Demarque, P., Kernan, P. J. and Krauss, L. M.: A lower limit on the age of the universe. *Science* **271**(#5251): 957-961 (1996). [DC Library call number: PER Q1.S35]