weekend box

Return to flat

Replied to thanks. mb

PRIME MINISTER

On my departure, I felt I should leave you a note about the future of the universe (culled largely from Scientific American)!

The big bang theory of the expanding universe is now generally accepted, and this allows some fairly confident predictions to be made about the next 10^{100} years. The main uncertainty is whether the universe is "closed" or "open". In a closed universe, there is sufficient matter to ensure that gravitational forces will stop the expansion of the universe and cause it to collapse upon itself. In an open universe, there is insufficient matter to cause such a contraction, and the universe expands indefinitely.

Assuming that the universe is open, 5 really significant events can be predicted:

(a) In 10^{14} years (100 million million years) all the stars in the universe will have exhausted their nuclear fuel. The sun will in fact have exhausted its fuel by 10^{9}, or 1 billion, years. The last stars will therefore cease to shine when the universe is 10,000 times as old as it is now.

(b) The second major event is that all stars will lose their planets. This will be caused by close encounters between stars. Statistical calculations show that it is safe to assume that all stars will have lost their planets by 10^{17} years, or when the universe is 10 million times as old as it is now.

(c) The third major event is also caused by close encounters between stars. By such encounters, stars may transfer kinetic energy to each other. Those that gain enough energy will escape from their galaxies. Those that lose energy will become more closely bound to the core of their galaxies. This process is very like evaporation. The dense cores of the galaxies will become super-massive black holes. By 10^{18} years, or when the universe is 100 million times as old as it is now, the universe will consist largely of super-massive black holes and dead stars.

((d)

(d) The next significant change will be caused by the decay of protons. This will have a significant effect on those stars that have not been captured by the galactic black holes. This process will take an enormously long time. It will have played itself out by the time the universe has existed for 10^{32} years. What will remain will be a rarified electron-positron gas, photons and neutrinos, and the super-massive galactic black holes. By this time, the universe will be vastly larger than it is now. By the year 10^{30} an open universe will have expanded to more than 10^{20} times (100 million million million times) its present size. The universe will remain in this state, albeit expanding, until roughly the year 10^{100}, a period lasting 10^{68} times as long as all the processes I have described so far.

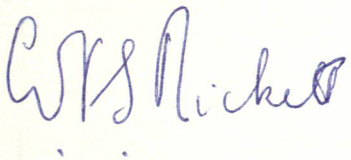
(e) The last major event in the future of the open universe is the decay of the black holes. It is commonly thought that nothing can escape a black hole. But in 1974 Professor Steven Hawking of Cambridge University showed that black holes can give up their energy through a quantum-mechanical phenomenon known as "tunnelling". By 10^{100} years, therefore, the universe will be made up of an extremely diffuse gas of electrons, positrons and neutrinos, and photons of various energies.

Most descriptions of a closed universe assume that the contraction will begin when the universe consists of galactic black holes and free dead stars, along with a soup of low energy photons and neutrinos. When such a contraction takes place the wavelength of all the particles concerned diminishes, and their energy therefore increases. The universe therefore runs hotter in contraction than in expansion. The first event in the contraction is the heating of the dead stars, which burn rapidly, explode or evaporate. The resulting soup of particles would continue to retrace the steps of the expansion of the universe if it were not for the black holes. These gobble up the surrounding material, and most descriptions end with the universe consisting solely of a single black hole. Theoretical physics cannot fully describe the collapse of a black hole, but it may be that before the density becomes infinite an unknown mechanism causes the

/ universe

universe to "bounce" and begin expanding once again. A closed universe could therefore by cyclic with each expansion followed by a contraction, a "bounce" and a further expansion. Because the particles would gain energy during the contractions, each successive cycle of the universe would be longer and larger.

Most people would assume that the human race would lose interest in the universe after another 10^9 years when our sun runs out of fuel. Some theoretical physicists, however, feel that intelligent species could obtain their energy needs at least until the decay of protons became significant, by about the year 10^{20}.



30 September 1983