Gamma ray effect on life

Periodic mass extinctions of life on earth have often been discussed. The latest mass extinction at the end of the cretaceous period, sixty five million years ago, virtually wiped out the dinosaurs ending their hundred million-year dominance of terra firma. At least, this particular extinction is now generally accepted as having been caused by the impact of a ten-kilometre diameter asteroid, which left a crater in the Yucatan peninsula.

Hardly ten years ago, comet ShoeMaker Levy broke up and impacted Jupiter with a force of several million megaton bombs. If it had struck the earth instead most life would have been snuffed out. There have been attempts to track all Near Earth Objects more than a km across (NEOs) and suggestions to destroy them or divert their path in case they are on a collision course with our planets.

It has also been suggested that some earlier mass extinctions could have been due to a nearby supernova (ten light years away). However, the most violent events in the universe are known to be gamma ray bursts (GRB). Everyday, two or three are recorded by space-based gamma ray telescopes. They generate energy in gamma rays alone in a few seconds equal in energy to the entire output of the sun in its whole lifetime of ten billion years.

Their concentrated beams of high energy would devastate planetary atmospheres even if they occured thousands of light years away! The Hubble Space Telescope has been used to image the host galaxies of about 42 of the long duration GRBs. Only one went off in a spiral galaxy (like ours), all others in irregular dwarf galaxies. Long GRBs are the result of collapse of very massive Wolf-Rayet (WR) stars, that is, they have lost their hydrogen and perhaps helium envelopes. Again, host galaxies of five of the nearest long GRBs (all closer than two billion light years) all have oxygen abundance about half that of our Milky Way (MW) galaxy. The higher the host galaxy's metallicity the lower the burst energy.

So, the progenitors are all of low metal content characteristic of the early epochs when metals were just being made in stars. The Milky Way's stars have become highly enriched in metals over years of stellar evolution. Most stars in our galaxy's disc are metal rich. So GRBs in our galaxy are (it is surmised) a negligible threat.

Conditions for life

So, two factors have worked to create favourable conditions for life in the universe. First, we had to wait a couple of billion years before stars with sufficient amount of metals (carbon, iron etc.) formed. The increase in metallicity also brought down the possibility of GRB explosions to destroy life! Supernovae can still be a threat. At least, once in 2-3 billion years a nearby supernova can threaten to make life extinct. What about short period GRBs (due to merger of neutron stars)?

Short period gamma ray bursts occur for about two seconds or less. Their gamma radiation is harder, although the total amount of energy released is less. Merger of neutron stars is a popular model for their origin. Since the discovery of the binary pulsar, 30 years ago, other such systems are known.

About two years ago, a binary neutron star with an orbital period of only two and half hours was discovered. Gravitational radiation from such a system is enough to make it merge. The two neutron stars merge in about a lakh years. Indeed, we can actually detect the two compact stars coming closer by several metres every month! (by the shortening of the period). The system is more than a kiloparsec away.

This ultimate merger of the two neutron stars would unleash a burst of gamma rays of energy a quadragintillion joules (ten followed by forty four zeros!). Even if such a source is away a thousand light years, the gamma ray flux on the whole earth from such a merger would be comparable to the combined radiation, released from all the nuclear warheads on the earth (about ten thousand megatons!). The ionosphere and ozone layer would be completely destroyed causing the extinction of most species. White dwarf binaries with periods of 5 minutes as well as neutron star-white dwarf binaries with ten-minute periods are also known. There could be binary neutron stars in our neighbourhood, a neutron star Geminga was found hardly sixty parsecs away.

Another type of energetic source is the soft gamma ray repeater (SGR). On December 26, 2004, a day after the tsunami, such a SGR did burst out. There was a powerful gamma ray burst, which in 0.2 seconds released as much energy as the sun radiates in five lakh years. Luckily the source was at the other end of the galaxy. Only our ionosphere was affected. These SGRs are known to be magnetars, neutron stars with magnetic fields, pentillion times stronger than the earth's. There was a similar such event on August 28, 2003. With all these cataclysms going on all around, the possibility of gamma ray outbursts of some sort affecting life on earth cannot be ruled out.

C Shivram

A gamma ray burst

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