The microscopic hitchhikers' guide to the Galaxy

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Cosmic radiation penetrating the atmosphere promotes the formation of clouds which have a cooling effect on Earth's climate. Credit: Danish National Space Center

As the Earth roams through the Milky Way like a spaceship, shelly inhabitants of the sea act as natural sensors that record the ever-changing cosmic environment over many millions of years. New research done by Henrik Svensmark at the Danish National Space Center shows that data from microscopic fossil seashells can be used to define important features of our Galaxy about which astronomers have been very uncertain.

According to Dr Svensmark's report, published in *Astronomische Nachrichten*, the Sun and Earth travel together at a speed of 18 kilometres per second relative to the Milky Way's pattern of bright spiral arms. They last passed through a major spiral arm 34 million years ago. The density of matter is 80 per cent higher in the spiral arms than in the darker spaces between them.

These and other numbers coming from the climatic analysis fall inside a wide range of previous suggestions, but the seashells tell the astronomers what the right numbers are, from a geological perspective. This is a surprising spin-off from Dr Svenmark's discovery that cosmic rays coming from exploded stars seem to have a big influence on the Earth's climate.

'Other experts have taken up our idea that cosmic rays cool the Earth by making it cloudier, and they have explained past alternations of hot and cold periods using the available astronomical data,' Dr Svensmark comments. 'Now I turn the reasoning around and calculate the astronomical data from the changes of climate over the past 200 million years.'

Nir Shaviv, an astrophysicist at the Racah Institute in Jerusalem, has argued that glacial episodes in the past 600 million years coincided with the passage of the Solar System through spiral arms of the Milky Way, where cosmic rays from exploded stars are particularly intense. Dr Shaviv has developed this astronomical approach to the climate in collaboration with a geologist, Ján Veizer of the University of Ottawa. Professor Veizer has amassed a long and detailed record of past variations in sea temperatures, using changes in the count of heavy oxygen atoms (O-18) in carbonate rocks formed by the microscopic fossils.

The chronicle of the rocks tells of major alternations of heat and cold

over cycles of about 140 million years, corresponding with the intervals between spiral-arm crossings. Superimposed are warmer-cooler cycles of about 34 million years, due to vertical motions through the mid-plane of the Milky Way where the cosmic rays are most concentrated. While the Sun, with the Earth in tow, circles around the centre of the Galaxy, it also jumps up and dives down through the mid-plane, like a dolphin playing at the sea surface. In Dr Svensmark's calculations, only one combination of key numbers describing the galactic environment gives the correct dolphin-like motions of the Sun needed to match the climate changes recorded by the microscopic shell-makers.

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Source: Danish National Space Center