Ice ages and the galaxy's spiral arms

Paleontology indicates that the earth has gone through a succession of ice epochs. Each of these general periods of glaciation lasts a few million years, during which there are repeated advances and retreats of the ice. Then the ice is more or less quiescent for about 250 million years, at which point another series of advances and retreats sets in.

A theory of extraordinary scope relating these cycles to movement of our solar system through spiral arms of the galaxy is now presented by W. H. McCrea, an astronomer at the University of Sussex in England (NATURE 255:607). To build his theory he combines a decades-old suggestion about what might trigger glaciation with the latest advances in the understanding of the structure of our galaxy.

In 1939 Fred Hoyle and R. A. Lyttleton—and even earlier than that, Harlow Shapley—proposed that terrestrial glaciations are initiated by dust falling into the sun. Suppose the sun enters a region of space that is thick with dust. Its gravity will attract some of the dust to fall into it. As it falls, that dust must give up energy. So the sun becomes, for a while, brighter than before. The extra solar radiation causes extra precipitation on earth, and it is the extra precipitation that is the major factor in making the ice advance.

So far, so good, says McCrea. It is a plausible theory of what might have happened, but not a theory of what *must* have happened. It is not a predictive theory and does not address itself to the cyclic part of the phenomenon.

It takes a knowledge of galactic structure that was not available in 1939 to do that. First, there is an astronomical cycle that commensurates rather exactly with that of the glacial epochs. The sun, carrying the solar system with it, revolves around the center of the galaxy once in 500 million years. Furthermore, as the sun moves it crosses oppositely placed spiral arms of the galaxy every 250 million years.

The latest ideas about the nature and stability of the spiral arms allow McCrea to argue that they have something to do with terrestrial glaciation. It used to be thought that the spiral arms were unstable in the long term. There is differential rotation: The outer parts rotate faster than the inner ones, and it was believed that this difference would wind up the arms tightly around the galactic center after some time. If so, the arms are not available as explanations for repetitive long-term phenomena.

But the more recent view is that the arms are stabler than that. They are now seen as manifestations of a pattern of shock waves that fans out through the matter of the galaxy. The bright spiral arm of stars represents one part of the wave. The dark dust lane, a strip of extra-dense

Spiral arms and dust lanes in NGC 5364.

dust that lies alongside the bright strip, represents another part of the wave. The pressure of the shock holds the arms more or less stable against the wind-up tendency.

McCrea proposes that the sun's passage through the dust lanes causes the glacial epochs, individual advances and retreats being the effect of variations in the densities of the individual dust clouds that make up the lane. He puts in numbers, and they come out right at least to the order of magnitude. Moreover, the idea rhymes with recent history. Astronomers place the sun now at the point of entering the so-called Orion arm of the galaxy. In other words, we have just emerged from the dust lane accompanying that arm and may in fact have passed through the Orion nebula itself. The last ice epoch ended only recently as geologic time goes, about 10,000 years ago.

So it all fits together neatly, and it prompts McCrea to go even further, though not in his NATURE paper but in his Halley lecture given at Oxford recently (reported in NEW SCIENTIST 66:695). He suggests that the sun's family of comets may be a relic of the recent passage through the Orion dust lane, being matter picked up on the way. The planets, too, could represent successive accretions of dust compressed by the effect of the shock and gradually built up on repeated passes. And if the planets come from interstellar dust, its variations have an important effect on how life may evolve on them. So the evolution of life may depend not only on a planet's distance from its star, but on that star's distance from the center of its galaxy, its speed of galactic rotation and the frequency with which it encounters spiral arms. On the whole, it's a really grand theoretical sweep. □

Outspoken chemist wins Priestley medal

Hammond: Photochemist, iconoclast, innovative teacher.

Chemist George Hammond, a prolific researcher, innovative educator and iconoclast in the field of chemistry, has been awarded that discipline's highest honor. He will receive the 1976 Priestley Medal at an American Chemical Society meeting next April.

Hammond is a professor of chemistry at the University of California at Santa Cruz, and is currently serving half-time as foreign secretary of the National Academy of Sciences. In his 27 years as an academic chemist, he has published more than 250 scientific papers and four books. His main interest has been photochemistry—understanding the behavior of short-lived, energetic chemical species created by the reaction of light energy on larger, more stable molecules. His work in recent years has included reactivity induced by gamma rays and the excited state processes of organometallic compounds.

He is perhaps as well known for his contributions to chemical education. He and a U.C. Santa Cruz colleague, Harry Gray, developed what has come to be called the "Hammond Curriculum" for undergraduate chemistry. The three-year program integrates traditional organic, inorganic and physical chemistry by approaching them from structural and dynamic principles, rather than as separate subdisciplines.

Hammond has publicly criticized traditional chemical education and research in recent years. Traditional curricula are inflexible and conservative, he maintains, and researchers are often more interested in elegance than innovation. But he sees chemistry's stodgy public image changing in recent years as its importance to environmental, energy and materials research is recognized more broadly. □