Ice Ages: As The World Turns

Ice ages are the result of regular, subtle changes in the earth's orbit, according to an hypothesis that is gathering statistical strength. Three years ago, researchers found evidence in deep sea cores that correlated the timing of the ice ages with three of the known periodic changes in the shape and orientation of the earth's orbit (SN: 12/14/76, p. 356). Now there is evidence for a fourth periodicity, affirming the so-called Astronomical, or Milankobitch, theory of ice ages.

Milutin Milankobitch, a Serbian geophysicist, suggested in the 1930s that climate changes may be due to variations in the earth's orbit because such variations affect the amount and distribution of sunlight received on earth. To test this theory Milankobitch worked out the orbital changes. He found four variations: On a cycle of 23,000 years the earth's elliptical orbit changes so that its closest approach to the sun varies (now earth and sun are closest in January; in 10,000 years they will be closest in July); on a cycle of 41,000 years the orbit tilts so that the earth's axis is more perpendicular to the sun, which reduces the contrast between seasons and prevents polar ice from melting; on cycles of 93,000 and 413,000 years the orbit changes from nearly circular to more elliptical, hence changing the seasonal distances between sun and earth.

Using sediment cores that recorded the last 450,000 years, past studies have found evidence for climatic changes that matched the 23,000-, 41,000- and 93,000-year cycles. Using 2-million-year sediment records, Madeleine Briskin and James Harrell of the University of Cincinnati have found evidence for climatic changes that correspond to the 413,000-year cycle proposed by Milankobitch. "This has never been seen," Briskin told Science News. "It nails the Milankobitch mechanism as the forcing mechanism for climate change," she says.

Briskin and Harrell, using 2-million-year sediment cores from both the Atlantic and Pacific, studied several climate-related parameters. To obtain a record of the amount of ice found in the polar caps, i.e. the extent of glaciation, they studied the ratio of the oxygen isotopes 0^{18} and 0^{16} in plankton remains. Periods of glaciation are detected by a relative increase in the amount of 0^{18} in the fossil plankton; during glaciation the lighter 0^{16} is bound up in the ice. Briskin and Harrell also looked for a "coarse fraction" in the sediments—heavier particles that would indicate greater erosion resulting from melting ice. In each parameter, the authors say, they found three complete cycles having an approximately 413,000-year "beat."

Interestingly, the researchers also found a periodicity in the magnetic inclination—the attitude in space of the magnetic field lines of earth as recorded by bits of magnetized rocks found in sediments. This may not be a climate-related effect, says Briskin, but she proposes that a relationship may exist between the eccentricity of the earth's orbit and the "internal churning" of the earth's core that produces the magnetic field. "The significance is that this was predicted by Milankobitch," says Briskin, "and it is there in the Pacific as well as in the Atlantic, in not one parameter but several."

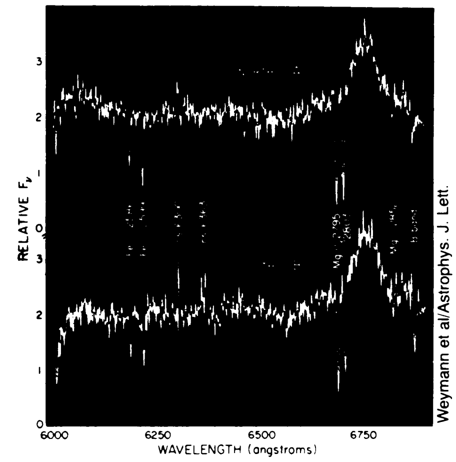
According to Briskin, the 413,000-year cycle had not been detected previously due to a lack of the appropriate statistical technique. The researchers applied a statistical technique to their data in order to detect an actual, rather than research-imagined, periodicity. Earlier techniques required a continuous record from which to choose equally spaced samples. Although adequate records exist for 450,000 years, longer sediment cores just aren't that complete. Briskin and Harrell, however, adapted a recently developed technique, which eliminates the problem of lost data, and used it on their 2-million-year-old sediment cores. □

Solid support for gravity's mirage

"... He's the devil, not a man, and he's cursed the burning sand with water. ..." Not everybody likes the sentimentality of country-western music, but nearly everybody who has traveled on the desert has seen the water mirage that bedevils the stumbling wayfarers in the song. In astronomy there is a prediction of a similar displaced and doubled image, but it is due to the action of gravity on light rather than that of the freakishly layered desert atmosphere.

Every desert has mirages, because every desert (on earth at least) has an atmosphere over it. Gravitational lens effect is very rare. Astronomers are now discussing what in fact may be the first example ever definitely noted, the recently discovered twin quasars, 0957+561 A,B (SN: 6/16/79, p. 389). These are two, apparently two, quasars that lie close together in the sky and appear to be identical. The chances of two quasars having identical properties are quite small, so the presumption is raised that one object is being seen twice. Now a study done in the Arizona desert (on Mt. Hopkins) using one of the world's newest and most radically designed telescopes, the Multiple Mirror Telescope, confirms and strengthens the impression of two images of one object.

If it is gravitational lens effect, it works like this: A distant object, the quasar, lies on a line of sight with a nearer, strongly gravitating, darkish body, say a heavily obscured galaxy. If the geometry is just right, the earth will get one set of light rays direct from the quasar and a second set that has started in a slightly different direction but has been bent by the gravity of the intervening object and comes to earth. The bent rays will reach earth from a slightly different angle than the direct rays so they will give a second image of the object displaced somewhat from the original, a quasar that appears to be there but really isn't.



0957+561 A,B, matching quasar spectra.

The present study was done by Ray J. Weymann of the University of Arizona, Frederic H. Chaffee Jr. of the Mt. Hopkins Observatory, Marc Davis and Nathaniel P. Carleton of the Harvard-Smithsonian Center for Astrophysics, D. Walsh of the Nuffield Radio Astronomy Laboratories in Jodrell Bank, England, and R.F. Carswell of the Institute of Astronomy of Cambridge University and is reported in the Oct. 15 Astrophysical Journal Letters. They were especially concerned with the widths and redshifts of the absorption lines in the spectra. They say the numbers they determine are hard to explain on the hypothesis of two different quasars. The gravitational lens hypothesis "significantly eases the difficulties" if the absorption is taking place in a cloud 300 kiloparsecs in front of the single quasar and the light enters the cloud on two lines of sight that started out from the quasar at an angle of 6 seconds from each other.

This is one of the first uses of the MMT for research. The automated drives for the six secondary mirrors were not yet ready, so the mirrors had to be positioned by hand to get it done. □