Astronomy

Ron Cowen reports from Edinburgh at a joint meeting of the Royal Astronomical Society and the European Astronomical Society

Death of the Great Attractor?

Eight years ago, astronomers reported evidence that the Milky Way and a host of other galaxies and galaxy clusters are moving toward a distant supercluster in the constellations of Hydra and Centaurus. To supply the gravitational tug that might account for such motion, the team proposed, a huge concentration of matter, dubbed the Great Attractor, must lie at least 150 million light-years from Earth (SN: 12/12/92, p.408).

But an astronomer now says that a key assumption used in calculating the velocities of elliptical galaxies in the Great Attractor study may harbor a fatal flaw. Elliptical galaxies in clusters are generally thought to contain only elderly stars. But increasing evidence suggests that at least some ellipticals outside of clusters have more youthful populations, notes Rafael Guzman of the University of Durham in England.

In assuming that ellipticals only have old stars, the Great Attractor team may have consistently underestimated the true distances to these galaxies and overestimated their motion, he says. When Guzman applies an age-independent measure of distance to these galaxies, the Great Attractor vanishes. Infrared observations should verify whether individual elliptical galaxies do contain substantial numbers of young stars, he adds.

Climate and sunspots: A historic link

Analyzing meteorological records from nearly 200 years ago, astronomers have found another association between Earth's climate and solar activity. John Butler and his colleagues at Armagh Observatory in Armagh, Northern Ireland, report that data gathered there as far back as 1795 show that the average air temperature varies with the length of the sunspot cycle.

Sunspots—dark, cooler regions on the sun's visible surface—are associated with intense magnetic activity. Their number typically waxes and wanes with an 11-year period, but that can vary considerably from cycle to cycle. The Armagh astronomers found that the highest temperatures correspond to years in which the cycle had a shorter-than-normal duration.

"Our data support the contention that solar variability has been the principal cause of temperature changes over the past 2 centuries," says Butler.

Scientists for over 100 years have attempted to link solar activity, including sunspots and solar flares, to the climate of our planet. In 1992, Danish meteorologists showed that variations in the length of the sunspot cycle seemed best correlated with fluctuations in temperature.

But because there exist few reliable measurements of temperature before 1865, the Danish researchers could not identify a correlation between temperature and the sunspot cycle that dated any earlier than the mid-1800s. In cataloguing astronomical manuscripts from the late 1700s and early 1800s, however, Butler and his collaborators uncovered a storehouse of early weather data. Combined with later temperature recordings at Armagh, the archival records reveal a link between sunspots and climate as far back as 1795, Butler notes.

Several factors suggest that the newly discovered Armagh data have significance, he adds. For example, the small variations in temperature between winter and summer in Northern Ireland allow scientists to calculate annual average temperatures accurately.

The exact mechanism linking the sunspot cycle to Earth's temperature remains unclear. Some scientists speculate that whenever the solar "engine" driving solar magnetic activity and sunspots increases speed, it prompts an increase in the energy emitted by the sun. Recent satellite images show that this increase can boost the total solar radiation received by Earth. However, researchers don't know if these periodic increases are large enough to account for the observed temperature swings.

Materials Science

Richard Lipkin reports from San Francisco at a meeting of the Materials Research Society

Are diamonds a transistor's best friend?

Diamonds, whose glistening surfaces have earned them a glamorous reputation, also display unique physical properties. These carbon crystals are mechanically strong, thermally conductive, radiation resistant, chemically inert, and biologically compatible. They also carry electric charges well.

This unusual blend of qualities makes diamonds potentially ideal for certain types of sensors and electronic components, especially ones that must operate in harsh conditions—say, in an airplane turbine, oil drill hole, nuclear power reactor, or even a vat of acid. To make measurements in such inhospitable environments, scientists often need remote sensors to relay information about what's happening there. From a practical standpoint, diamond electronics would make a difference.

Now, David L. Dreifus, a researcher at Kobe Steel USA in Research Triangle Park, N.C., reports making a functioning diamond field-effect transistor. These devices are similar to ordinary transistors found in cordless telephones and pocket radios, but they will operate at temperatures as hot as 550°C.

"In terms of field-effect transistors, this one has the best performance so far of any device made with diamond," Dreifus asserts. "This is by far the highest operating temperature."

Dreifus says his group will continue to explore how diamond transports free electrical charges. Using computer modeling, they also hope to improve transistor performance.

"We've made some simple digital logic circuits, some amplifiers, a few other devices. This is a large leap from the concept that diamond transistors could be useful," Dreifus says. "These transistors actually work."

Better magnetic refrigeration

In some materials, a magnetic field can cause cooling.

Scientists have known about this phenomenon, the magnetocaloric effect, since the turn of the century, when the technique was first used to cool liquid oxygen.

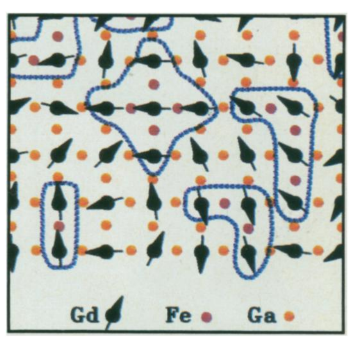
In essence, the effect works like this: Exposing a substance to a magnetic field causes its atoms to point in the same direction. When that magnetic field is taken away, the atoms rotate randomly. This change creates a cooling effect.

Near absolute zero, this effect works very well. Above 15 kelvins, however, existing materials don't cool effectively. The problem, says Robert D. Shull, a researcher at the National Institute of Standards and Technology in Gaithersburg, Md., stems from inherent limitations in the cooled compounds.

"To increase the operating temperature of a magnetic refrigerator," he says, "we need new materials."

Shull's group now reports making a new composite that shows a magnetocaloric effect three to four times larger than the effect exhibited by current materials. Made of gadolinium, gallium, iron, and oxygen, the new substance produces cooling at less frigid temperatures, and it requires a less intense magnetic field, Shull says.

Household magnetic air conditioners and fridges remain a long way off. At present, magnetic cooling requires temperatures near absolute zero, making this technique impractical for home use. But Shull believes that, at least in theory, magnetically cooled ice cream "is possible."



Shull *et al.*

A magnetic field aligns gadolinium atoms (inside dashed lines), but not their neighbors. Stopping the magnetic field cools the material.