bulging pancake, the galaxy's true shape is very different, asserts Steiman-Cameron. Estimating the disk's age and using Kormendy's image to analyze the amount of twisting, he and his research team conclude that NGC 4753 has a nearly spherical shape.

The dark, or unseen, matter in the galaxy must take the shape of a slightly flattened sphere and accounts for the vast majority of the total mass in NGC 4753, report Steiman-Cameron, Durisen, and Kormendy in the October ASTRONOMICAL JOURNAL.

Theorist Scott D. Tremaine of the University of Toronto says he agrees that twisted disks can reveal the geometry of dark matter in a galaxy. But he adds that the details of the team's calculations need to be repeated using other galaxies. "If they had 12 galaxies like this, everyone would sit up and take notice," Tremaine says. "But with just one case, you have to be cautious."

He adds that the near-spherical shape of dark matter inferred by the researchers may challenge theorists, who have postulated that galactic dark matter has a far flatter shape. But he notes that the finding generally agrees with dark matter estimates inferred from observations of polar-ring galaxies — bodies in which a ring of gas and dust orbits at nearly right angles to the plane of the galaxy. *— R. Cowen*

Cutting magnets down to quantum-effect size

The rules of quantum mechanics allow the safe passage of a truck *through* a mountain instead of over it. But for objects larger than an atom, such extraordinary events have an extremely low probability of happening because of the objects' size.

Nonetheless, theorists have suggested that quantum tunneling may occur not only in submicroscopic systems, but also on a macroscopic scale — in tiny magnets made up of several thousand atoms each. Using naturally produced magnets encased in protein molecules, researchers have now obtained a hint that quantum tunneling within a magnet allows a transition from one magnetic field direction to another to occur in large aggregations of atoms or ions.

"Our interest is in testing whether macroscopic quantum phenomena can be directly observed experimentally," says physicist David D. Awschalom of the University of California, Santa Barbara. The idea that quantum tunneling can occur in sufficiently small magnets also has important technological implications as a fundamental barrier to ongoing efforts to pack increasing amounts of information on magnetic tapes or disks.

To search for macroscopic quantum tunneling, Awschalom and his co-workers turned to a protein known as ferritin, which serves as a storehouse for iron in cells. Each protein molecule has a magnetic core containing about 4,500 iron ions. In this particular case, the spins of neighboring ions line up parallel to each other but in opposite directions to create what is known as an antiferromagnet.

"The whole magnet acts like one big quantum particle — one big spin — which could point up or down," Awschalom says.

To measure the exceedingly weak magnetic fields involved, the researchers used advanced superconducting sensors and performed their experiments at temperatures below 1 kelvin. They describe their technique in the Oct. 16 SCIENCE.

The measurements revealed that ferritin molecules strongly absorb electromagnetic radiation at a frequency near 1 megahertz. Awschalom and his colleagues attribute that absorption to quantum tunneling back and forth between two particular magnetic states.

"It's qualitatively consistent with all of the quantum-mechanical predictions in terms of temperature, field, and density — every parameter that we varied," Awschalom says. "Though some of the numbers are not in exact agreement, there is no other self-consistent explanation that anyone's been able to provide."

Other researchers remain skeptical. "I think their technique is very interesting and promising," says Anupam Garg of Northwestern University in Evanston, Ill., "but I'm very doubtful that they're seeing macroscopic quantum coherence."

One problem involves uncertainties in the geometry of the magnetic protein cores. "If one were actually capable of making such small particles, one would have to be very careful in how one aligns them, and one would have to expend considerable effort characterizing them," Garg notes.

Similar concerns surround earlier work done by B. Barbara and co-workers at the Louis Néel Laboratory of Magnetism in Grenoble, France. Their findings also revealed an unusual magnetic effect that they attributed to quantum tunneling in ferromagnetic particles somewhat larger than those used by Awschalom's group.

"No one has yet done the conclusive experiment," says Philip C. E. Stamp of the University of British Columbia in Vancouver. "There are hopeful signs, but there is no proof."

Awschalom and his group are now looking for quantum tunneling in precisely manufactured magnetic particles about 100 times larger than the 7.5-nanometer, naturally occurring protein magnets they had previously used. "We've spent a year and half making these particles, which is the hard part," Awschalom says. "We're measuring [their magnetic properties] now." *— I. Peterson*

Taking the measure of volcanic eruptions

The size of a volcanic eruption — and its potential to threaten nearby population centers — depends on processes that occur deep underground, hidden from the eyes of curious scientists and anxious disaster planners.

But chemical analysis of lava may allow scientists to forecast the size of ongoing or future eruptions, say geochemist Donald J. DePaolo of the University of California, Berkeley, and his collaborators in the United States and Japan.

In a study presented this week at the Geological Society of America meeting in Cincinnati, the researchers argue that certain isotopic ratios in lava — notably, high neodymium-143 to neodymium-144 — can indicate whether a volcanic system is undergoing a major eruption.

Although using lava composition to infer the behavior of vast underground magma systems is not new, DePaolo's model is the first to link certain combinations of elements in lava directly to eruption volume, he says.

DePaolo's group bases its study on lavas disgorged by Japan's Unzen volcano over the past 300,000 years. Unzen, located on the Simabara peninsula of western Kyushu, began its latest eruption in 1990 after lying dormant nearly 200 years.

Chemical analysis of the material ejected by Unzen both before and since its 1990 outburst indicates that the volcano is probably in the middle of a relatively large eruption, says DePaolo.

Unlike large systems that take millenniums to build up enough energy for a major outburst, some volcanoes' cycles can be measured in decades. Thus, chemical analysis of the precursory burps of a small volcano may yield a rough estimate of when the Big One will erupt. Such a forecast could be valuable to current or future generations living near such a volcano.

DePaolo cautions, however, that chemical messages from magma chambers are no sure thing. Although the chemical composition of lava may indicate that a large eruption is imminent, "it doesn't guarantee you're going to get one," he notes.

Geochemist Alexander N. Halliday of the University of Michigan in Ann Arbor says that DePaolo's model of magma chambers is essentially sound, although it may not work for all volcanoes. "There are some systems that I don't think fit so well," he says. *— D. Pendick*