

Strong Evidence For Flavor Oscillation In Atmospheric Neutrinos

As we go to press, the applause has barely subsided for a 5 June talk by Takaaki Kajita at the Neutrino '98 conference in Takayama in the Japanese Alps, not far from the 50-kiloton Super Kamiokande underground water-Cherenkov neutrino detector. Speaking for the Japanese-American Super Kamiokande collaboration, Kajita reported by far the most convincing evidence to date of oscillation between different neutrino flavors. The evidence comes from the high-statistics observation of neutrinos created by cosmic-ray showers in the atmosphere. It appears that muon neutrinos on their way to the detector are exhibiting oscillatory metamorphosis into something *other than* electron neutrinos. Neutrino oscillation cannot happen if all flavors are massless. Details in the next issue. **BERTRAM SCHWARZSCHILD**

induced by solar winds or other sources of electrical currents in the ionosphere. The ratio of the electric to magnetic fields gives the complex impedance, from which one can extract the conductivity. The frequency bands are taken as a measure of the depth, with higher frequencies providing information about shallower structures. However, the data analysis is quite complicated. According to Evans, magnetotelluric results are a bit nonintuitive because one region of high conductivity will affect the value of fields throughout the region. So far, he and his colleagues have done what he calls "forward modeling," seeing if the data are consistent with certain patterns of conductivity. But they have not exhaustively explored the possibilities.

According to the MELT team's preliminary results, the background mantle structure agrees well with that

measured in a 1995 magnetotelluric study along a line from California to Hawaii.⁸ For a broad region in the upper 100 km beneath the East Pacific Rise, the researchers see conductivities that are higher than expected for a dry mantle. However, the conductivity is not high enough to support any more than about 1% of interconnected melt in that region. More melt may be present, but unless the pockets of melt are connected to one another, they will not have a substantial impact on the electrical conductivity. The conductive region may be broader to the west than to the east of the ridge crest. It is also possible that there is a narrow (only 10 km wide) region containing 4% of interconnected melt directly beneath the ridge, but this scenario is not required by the MELT team's data.

The magnetotelluric data reveal a striking anomaly: a region of high con-

ductivity at a depth of about 170 km, which the research team needs to explore more closely. Doing so will involve examining the role of water in the mantle. Water can raise the conductivity, of course, and maybe that alone is the cause of the high conductivity at 170 km. But when melt occurs (perhaps higher up in the mantle), the water can enter the mantle's melt phase, causing the remaining mantle to be drier.

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Microcalorimeters May Provide a Solution to the Big Problem of Small Contaminants

As microelectronic devices continue to shrink, submicrometer-sized contaminants pose a serious threat to semiconductor yields and performance—and thereby to the profits of the nearly \$200 billion a year industry. Chemical analysis of these tiny particles can suggest remedies for avoiding contamination by helping to pinpoint its sources. One of the most successful microchemical analysis tools combines electron microscopy with spectroscopic analysis of x rays excited in the target impurity by the microscope's electron beam. Unfortunately, the choice of x-ray detector has traditionally involved a trade-off between energy resolution and speed. So the semiconductor industry—where time equals a lot of money—has often had to supplement spectrometry with educated guesswork. Now, John Martinis, Kent Irwin, Gene Hilton and David Wollman, working at the National Institute of Standards and Technology facility in Boulder, Colorado, have developed an

In a drive to help the US semiconductor industry, researchers are developing x-ray spectrometers that will be able not just to identify any element in microscopic contaminants, but also to yield information about the element's chemical state.

x-ray detector^{1,2} that they hope will remove some of that guesswork.

In general, x-ray spectroscopy can be performed by two types of devices—wavelength-dispersive and energy-dispersive spectrometers. Wavelength-dispersive spectrometers use crystals to Bragg scatter x rays, which are then counted by a gas proportional counter. The short dead times of these counters make possible counting rates as high as 50 000 per second, and the narrow wavelength range scattered at the Bragg angle ensures excellent energy resolution. However, scanning over the entire x-ray spectrum (50 eV to 20 keV) in this mode involves changing

the scattering crystal orientation and switching between crystals—a very time consuming process.

In contrast, energy-dispersive spectrometers use a detector that measures the energy of each incident x ray, simultaneously covering the entire energy range of interest. In spite of the fact that their energy resolution is significantly worse, energy-dispersive spectrometers perform their function so much more quickly and cheaply than their wavelength-dispersive counterparts that they dominate the semiconductor industry.

For over a decade, researchers^{1,3,4} have been developing improved x-ray spectrometers based on microcalorimeters, which use sensitive thermometers to determine individual x-ray energies by measuring the temperature change they produce in an x-ray absorber. With the ability to cover the entire x-ray spectrum simultaneously and theoretical energy resolutions rivaling those of wavelength-dispersive spec-