SNO and the Missing Solar Neutrinos

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(On the occasion of the opening of the
Sudbury Neutrino Observatory)

The Sudbury Neutrino Observatory is designed to solve the longest standing scientific mystery: "The Case of the Missing Neutrinos." Since 1968, for 30 long years, we have known that fewer solar neutrinos are detected on earth than is predicted by the standard theories of elementary particle physics and by modern theories of how stars shine.

What are the mysterious missing solar neutrinos? Hold out your thumb in front of you. Now look at your thumbnail. Every second, according to modern scientific theories, about a hundred billion neutrinos pass through your thumbnail. And you don't feel the neutrinos at all; they pass through your thumb without affecting anything. Neutrinos travel at essentially the speed of light and have, at most, a very tiny mass. Professor Hawking's talk this evening will be on "The Theory of Everything." By contrast, my

remarks on solar neutrinos might have been entitled "The Theory of Almost Nothing."

So, what is all the fuss about? Why to scientists so desperately want to know what happened to the missing neutrinos? The sun shines by burning hydrogen nuclei to supply the enormous solar energy that is radiated in part toward earth and which makes possible life on this planet. The neutrinos that are produced in the sun are the type that are associated with atomic electrons; these neutrinos are called "electron-type" neutrinos. There are two other types of neutrinos. Many physicists believe that the electron-type solar neutrinos are not really missing; they are just unrecognized by previous detectors. In this scenario, the mystery is solved by having the missing electron-type neutrinos arrive at earth disguised as one of the other types of neutrinos. These other neutrinos are more difficult to detect than electron-type neutrinos. If correct, this scenario indicates that solar neutrino research is revealing the first clear evidence of new particle physics beyond what is written in the textbooks.

How will SNO solve the mystery? Using the specific characteristics of heavy water, the SNO observatory will search for "smoking guns" that might prove that the missing solar neutrinos have changed their outward appear-

ance, but have not been lost. Among all the experiments operating around the world, only SNO can count the total number of solar neutrinos arriving at earth. SNO can look also for evidence of new physics in other ways. For example, the sun may appear brighter at night in neutrinos and the ratio of the number of higher energy to lower energy neutrinos may be different from the predictions of textbook physics.

You may well ask: "Can SNO really do that?" In this connection, let me share a personal experience with you. In the last few days, I was at a meeting of the U.S. National Academy of Sciences in Washington, D. C. When we started talking at the coffee breaks, people continually came up to me and asked: "How is it going with SNO? Is there any news?" Scientists like to gossip about their colleagues and their work just as – I believe – lawyers and doctors and business men and politicians gossip about their colleagues and their work. But, what people say about SNO is rare. Here is a typical comment from a competitor, which I wrote down when I was in Washington: "Boy, that SNO collaboration is as really competent, able group and they have designed such a beautiful experiment."

On behalf of the international scientific community, I congratulate the SNO scientists and engineers, the far-sighted public servants, the dedicated

miners, the Inco Mining Company, and the enthusiastic private citizens who have all joined together to make possible this wonderful experiment. An incredible amount of hard work has been accomplished. But, as the SNO scientists know, even greater challenges lie ahead. I am sure that all of you join with me in assuring the SNO extended family that they have our support and our admiration as they proceed to solve, finally, "The Case of the Missing Neutrinos."