Tiny particles may illuminate reactor cores

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Using particles from space to look into the heart of nuclear reactors - this is the goal of researchers at Nagoya University.

The Yomiuri Shimbun has learned that a team of researchers from the university is developing technology to use elementary particles from space to see into the interiors of crippled reactors at the Fukushima No. 1 nuclear power plant.

Their aim is to establish technology that can obtain images similar to X-rays of what is happening inside the Nos. 1 to 3 reactors, whose cores melted down in the wake of the March 11 earthquake and tsunami.

Tokyo Electric Power Co. plans to start operations to move melted-down nuclear fuel out of the reactors within the coming 10 years as a step toward decommissioning them.

To do so, the power utility must know exactly where the lumps of nuclear fuel are in the reactors. The government has therefore thrown its support behind the critical project at Nagoya University.

The university team is scheduled to launch studies on practical use of the envisaged technology when the amount of radiation being emitted from the reactors is reduced, making it possible for members to work nearby.

The team comprises researchers at the state-run university's Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, and is led by Associate Professor Mitsuhiro Nakamura of the university.

The researchers are using elementary muon particles in lieu of X-rays. Muon particles are one of 12 kinds of elementary particles that constitute matter. They have properties similar to electrons, but weigh about 200 times more, and fall to Earth from space at a rate of one particle onto a person's palm per second.

Muon particles have a strong ability to penetrate substances, but are absorbed in proportion to the concentration of those substances. The greater the density of the substance they pass through, the more muon particles are absorbed and the more their number declines, according to the study team.

Observation of muon particles penetrating the reactors will make it possible to determine differences in density within the reactors, the researchers said.

By setting a special film measuring one square meter near each of the reactors, researchers will be able to create an image of their interiors based on the muon particles penetrating the reactors, they said.

As the density of nuclear fuel is higher than steel and other materials used in the reactors, the areas containing the fuel will appear paler than the images of other materials on the special film, making it possible to determine the exact locations and shapes of melted-down nuclear fuel, the researchers said.

The Nagoya University group successfully observed the bottom of the crater of Mt. Showa Shinzan, a volcano in Hokkaido, in collaboration with the University of Tokyo in 2007, obtaining images of magma locations.

Nakamura took the initiative in starting the reactor fluoroscopy project after the March 11 disaster.

The Japan Science and Technology Agency of the Education, Culture, Sports, Science and Technology Ministry has designated the research project eligible for receiving government subsidies from fiscal year 2011 to FY 2014.

When the fluoroscopy method is applied to reactors, however, the special film may be affected by gamma rays emitted from the reactors, the researchers said. Gamma rays also have strong powers of penetration.

The research team therefore plans to shield the reactors with lead, so only muon particles can be detected.

The exact locations of the melted-down nuclear material in the Nos. 1 to 3 reactors and their container vessels are currently unknown.