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Watson Lecture: Creating Laboratory Earthquakes

What They Can Teach Us

The recent 7.0-magnitude Haiti earthquake on January 12 caused catastrophic damage to the island nation—once again reminding us that these natural disasters are ever-present and that their force can be devastating. And locally, leading scientists have concluded that a 7.8-magnitude earthquake could occur on the San Andreas Fault, which would cause major damage to the infrastructure, crippling California and the West Coast.

Now imagine an extremely fast or “inter-sonic” earthquake that produces a shock-wave pattern similar to a jet fighter breaking the sound barrier. Imagine the effect on buildings and structures of the shock wave or Mach cone, as it is called, produced by such an earthquake. The propagating waves generated by such special ruptures could produce potentially catastrophic ground shaking—equivalent to a sonic boom traveling through the ground—with unexpected implications to seismic hazard analysis.

Scientists at the California Institute of Technology (Caltech) have demonstrated that these high-speed inter-sonic ruptures, which propagate at speeds between three to six kilometers per second, do exist and could occur during the next major earthquake. Utilizing an innovative methodology, Caltech researchers now have the ability to create laboratory earthquakes of varying force and magnitudes that mimic actual quakes. By triggering laboratory earthquakes, researchers can utilize ultrahigh-speed imaging tools to study the behavior of quakes, the force of wave propagation, and inter-sonic rupture impact, allowing better measurement of the potential force and destructiveness of earthquakes—without a real quake actually occurring.

The scientists have also developed complex simulations of the effects of these shock waves on buildings and the likelihood of Southern California buildings and structures to withstand this type of impact. These high-performance simulations can determine ground motion, rupture propagation, and structural response, to help ultimately identify remedial measures to prevent the collapse of buildings.

In his Earnest C. Watson Lecture on February 17, at 8 p.m., Ares Rosakis, the Theodore von Karman Professor of Aeronautics and professor of mechanical engineering; chair, Division of Engineering and Applied Science, will present a talk entitled “Inter-sonic Earthquakes: What Laboratory Earthquakes Teach Us About Real Ones.” He will explain how his team of collaborators has demonstrated the existence of inter-sonic earthquakes. He will discuss his research for triggering laboratory-generated earthquakes, and will also discuss simulation methodologies for determining the probability of building collapse and structural damage and for estimating loss. His colleagues on these findings include professors Hiroo Kanamori, Swaminathan Krishnan, and Nadia Lapusta; graduate student Michael Mello; and postdoctoral scholar Harsha Bhat.

Studying earthquakes inherently presents a host of insurmountable difficulties—for example, our inability to trigger a “real” quake or control the magnitude or speed of rupture propagation.

Laboratory-generated quakes give us an opportunity to measure and obtain valuable information that can better prepare us for the mitigation of potentially destructive hazards.

The lecture will take place in Beckman Auditorium, 332 S. Michigan Avenue, south of Del Mar Boulevard, on the Caltech campus in Pasadena. Seating is available on a free, first-come, first-served basis.

For over 85 years, Caltech has presented the Earnest C. Watson Lecture Series. It was conceived by the late Caltech physicist Earnest Watson as a way to provide scientific insight for the general public and local community.

Upcoming lectures in the 2009-2010 series include:

- April 7, “The Ancient California River and How It Carved the Grand Canyon in the Age of T. Rex,” by Brian P. Wernicke, Chandler Family Professor of Geology;
- May 5, “From Newton’s Cradle to New Materials,” by Chiara Daraio, assistant professor of aeronautics and applied physics;
- May 19, “Neuronal Mechanisms of Memory Formation,” by Thanos Siapas, associate professor of computation and neural systems and Bren Scholar.

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