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OMEN - Observing the Mechanisms of Earthquake Nucleation

Earthquakes are one of the most expressive phenomena of our planet, able to suddenly reshape the surface of the Earth and affect countless lives every year. Any effort towards earthquake forecast and hazard mitigation must rely on a profound comprehension of seismogenesis. However, earthquakes are phenomena that emerge from a complex, dynamic system of mechanisms that operate at inaccessible depths within the Earth. The impossibility to directly observe the birth of an earthquake (i.e., the “nucleation”) frustrates our effort to have new breakthroughs on their physics. The overarching goal of OMEN is to directly observe the mechanisms of earthquake nucleation to allow for a step-change in our understanding of seismic slip and its potential precursors. OMEN will overcome the current experimental approaches that rely only on the indirect measure of sample properties and/or use of rock analogue materials. With an innovative rock-deformation apparatus and the use of transparent high-tech glass, I will be able to simulate and, for the first time, film the birth of earthquakes in natural fault rocks at hypocentral conditions. This method, in combination with several investigation techniques (visible and infrared footage, acoustic emissions, deep learning-assisted image analysis etc.), will offer unprecedented detail on the processes during the preparation and propagation of seismic slip. In particular, I will shed new light on how the complexity of natural rocks affect the dynamics, resulting into the formulation of a new, more reliable physical framework for the description of earthquake nucleation. Laboratory and theoretical results will be upscaled to nature thanks to the integration of microstructural and field studies of natural faults. OMEN is the unique opportunity to open a literal window into the dynamics of earthquakes, shifting the paradigm from an empirically quantitative documentation to a direct and truly quantitative observation.

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