

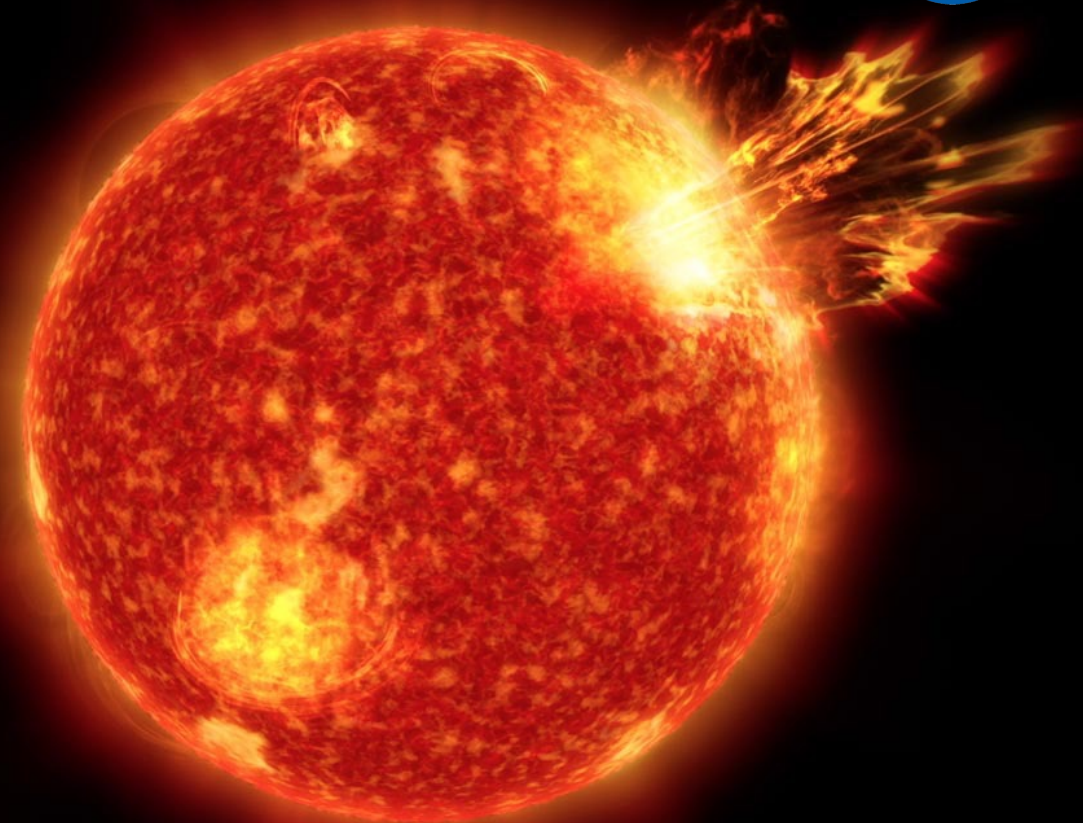
Eruptions From Young Solar-Type Stars



Young solar-type stars frequently produce superflares that are many orders of magnitude larger than the largest observed solar flares. Large solar flares are closely linked to huge eruptions of material on the sun called coronal mass ejections (CMEs). The observational evidence for CMEs associated with stellar superflares remains scarce.

A 12-day multi-wavelength (optical and X-ray) observation campaign of the young solar-type star EK Draconis using TESS, NICER, and the Seimei telescope provided the first discovery of two large CMEs associated with stellar superflares. Young solar-type stars can now be used as a proxy to study the young sun. They especially provide a unique window into the young Sun-Earth environments.

These discoveries provide profound implications of impact of these eruptive events on the early Venus, Earth and Mars and young exoplanets. This also helps to redefine the traditional definition of habitability and the importance of the host star on a planet's ability to foster life.



Artist concept of our sun 4 billion years ago. Energy from our young sun – 4 billion years ago – illustrating a massive solar eruption.

Kosuke Namekata, Vladimir S. Airapetian (AU/671), Pascal Petit, Hiroyuki Maehara, Kai Ikuta Shun Inoue, Yuta Notsu, Rishi R. Paudel (UMD/662), Zaven Arzoumanian (662), Antoaneta, A. Avramova-Boncheva, Keith Gendreau, Sandra V. Jeffers, Stephen Marsden, Julien Morin, Coralie Neiner, Aline A. Vidotto, and Kazunari Shibata, 2023: "Multi-wavelength Campaign Observations of a Young Solar-type Star, EK Draconis I. Discovery of Prominence Eruptions Associated with Superflares," *The Astrophysical Journal*.