

# Connection between stellar flares and starspots

Emilia Rintamäki

March 5, 2025

Magnetic fields play an important role in the behavior of stars. A mechanism called stellar dynamo generates the magnetic activity of stars with convective envelopes, such as the Sun. Magnetic activity causes different observable phenomena on the star's surface, such as starspots and stellar flares.

Starspots are dark spots on a stellar surface. When observed on the Sun, they are called sunspots. In 1908, the connection between sunspots and magnetic fields was discovered by George E. Hale. Sunspots are formed when a strong magnetic field penetrates the solar surface and inhibits convection, which in turn restrains the rise of hot plasma from the interior layers to the surface. Thus, the spots are cooler and darker than their surroundings.

Stellar flares are bursts of electromagnetic radiation that release magnetic energy into the stellar atmosphere, which can last from seconds to days. Flares are mostly observed on stars with convective envelopes. The flares observed on the Sun, i.e. solar flares, have an effect on everyday life and modern technology on Earth. Satellites in particular can be damaged during solar flares.

Stellar magnetic activity can be studied by analysing photometric light curves that reveal variations in the star's brightness. Periodic variations in brightness are caused by rotation and starspots. As the star rotates, the spots move in and out of the observer's view. The spots emit less light than its surroundings, and therefore, the star seems dimmer when the spots are visible. In addition, light curves can be used for identifying stellar flares that cause sudden irregular brightenings.

This study examines flares of two solar-type stars (LQ Hya and V889 Her) and their connection with starspots. The connection is studied by analysing light curves observed by the Transiting Exoplanet Survey Satellite (TESS). The flares are identified from the light curves with a program based on a support vector machine. If the flares seem to occur more frequently during light curve minima, the flares may originate from the starspots.

The program manages to detect 40 flare candidates, of which 29 are accepted as flares. Statistical analysis reveals no clear correlation between the flares and the starspots. On the contrary, the flares seem to occur most rarely during light curve minima, which contradicts the assumptions.

It is crucial to understand and be able to predict the behavior of the Sun due to its impact on Earth. The research of solar-type stars is a way to gain important knowledge of the Sun and its magnetic activity.