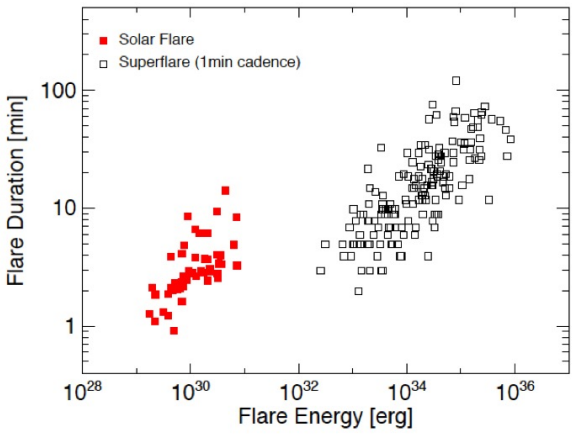
Observational Studies on Solar Flares toward an Understanding of Energy Release Mechanism of Stellar Flares (修士論文)

Recently, many "superflares" were discovered on solar-type stars whose energies are 10–10,000 times larger than those of the maximum solar flares ($\sim 10^{32}$ erg). Interestingly, these superflares are discovered as "white-light flares", whose emission mechanism is not yet understood. The statistical study found a correlation between their energies (E) and durations (τ): $\tau \propto E^{0.39}$ (Maehara et al. 2015, EP&S), which can be explained by a theoretical scaling law ($\tau \propto E^{1/3}$) derived based on the magnetic reconnection theory.

A direct comparison between solar flares and stellar superflares on the white-light range is expected to give the clear evidence about the energy release mechanism of superflares. We carried out a statistical research on 50 solar white-light flares with SDO/HMI and examined the E–τ relation. A figure shows the result of comparison of energy and duration of solar and stellar white-light flares. The E–τ relation on solar white-light flares ($\tau \propto E^{0.38}$) is quite similar to that on stellar superflares ($\tau \propto E^{0.39}$), while the durations of stellar superflares are one order of magnitude shorter than those expected from solar white-light flares.

One interpretation is that the distribution can be understood by strong coronal magnetic field of superflares. In detail, we derived a theoretical scaling law of energy and duration of flares with the dependence of coronal magnetic field strength B as $\tau \propto E^{1/3}B^{-5/3}$. On the basis of the scaling law, the observed discrepancy can be explained by the strong B of superflares, and the observed superflares are expected to have 2-4 times stronger magnetic field strength than solar flares. The result would be an important for the universal understandings of the energy release mechanism on solar and stellar flares, so more research on stellar flares are necessary.



Reference:
Namekata, K., Sakaue, T., Watanabe, K., et al. 2017, ApJ, 851, 91

(行方宏介 記)