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On the Possibility of Solar Superflares

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Recent observations of Sun-like stars, similar to our Sun in their surface temperature (5600 K - 6000 K) and slow rotation (rotational period > 10 days), with the Kepler satellite by Maehara et al. (2012, Nature) have revealed the existence of superflares (with energy of 10^33 - 10^35 erg). From the statistical analysis of these superflares, it was found that superflares with energy 10^34 erg occur once in 800 years and superflares with 1035 erg occur once in 5000 years. In this paper, we examine whether superflares with energy of 10^33 - 10^35 erg could occur on the present Sun through the use of simple order-of-magnitude estimates based on current ideas relating to the mechanisms of the solar dynamo. If magnetic flux is generated by the differential rotation at the base of convection zone as assumed in typical dynamo models, it is possible that the present Sun would generate a large sunspot with total magnetic flux 2 x 10^23 Mx within one solar cycle period, and lead to superflares with energy of 10^34 erg. To store total magnetic flux 10^24 Mx necessary for generating 10^35 erg superflares it would take 40 years. Hot Jupiters have often been argued to be a necessary ingredient for generation of superflares, but we found they do not play any essential role on generation of magnetic flux in the star itself, if we consider only magnetic interaction between the star and the hot Jupiter. This seems to be consistent with Maehara et al.'s finding of 148 superflare-generating solar type stars which do not have a hot Jupiter companion. Altogether, our simple calculations, combined with Maehara et al.'s analysis of superflares on Sun-like stars, show that there is a possibility that superflares of 10^34 erg would occur once in 800 years on our present Sun.

The contents of this talk is based on the paper which will be published in PASJ, 2013, by Kazunari Shibata, Hiroaki Isobe, Andrew Hillier, Arnab Rai Choudhuri, Hiroyuki Maehara, Takako T. Ishii, Takuya Shibayama, Shota Notsu, Yuta Notsu, Takashi Nagao, Satoshi Honda, and Daisaku Nogami.

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