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# Analysis of Characteristics of Light Curve Profiles of the Flares Erupted from Sun-like Stars† ⋆

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**Abstract** Solar flares belong to a kind of eruptive phenomena caused by the sudden release of magnetic energy nearby sunspots. It is found that similar flares occurred as well in many Sun-like stars (called as Sun-like star flares). From the data acquired by the Kepler space telescope the SC (Short Cadence) data are mainly selected to make analysis, in order to find the characteristic parameters of light curve profiles of the flares erupted from Sun-like stars for a statistical study, and to summarize the activity features of these stellar flares. The analyzed results show that the light curve profiles and characteristic timescales of the flares of Sun-like stars are quite similar to those of solar flares, which may indicate the same physical mechanism for these two kinds of flares.

**Key words** stars: flares—stars: Sun-like—time—methods: statistical

## 1. INTRODUCTION

Solar flares are one of the most violent phenomenon of solar activities, the eruptions of solar flares are commonly accompanied by a series of energetic radiations. The frequency and intensity of flare activities are considered to be an important parameter for describing the strength of solar activities. Similar to solar flares, violent flare activities can also happen in the Sun-like stars. In this paper, we mainly study the features of light curve profiles of the Sun-like star flares observed by the Kepler space telescope[1]. The energy of a Sun-like star

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flare observed by the Kepler space telescope is $10^{33}\sim10^{37}$ erg[2], which belongs to the white light flare, and it is higher than the maximum energy of a solar flare (about $10^{32}$ erg)[3,4].

It is found by recent studies that there are some similarities between the physical mechanisms of Sun-like star flares and solar flares[5,6]. Candelaresi et al. studied the origin of super flares of $E>10^{34}$erg from the Kepler data of G, K, and M type stars, and obtained the results that the occurrence rate of super flares decreases with the increase of effective temperature, and the coverage rate of black spots is higher for the stars with a small rotation period[7]. In addition, Frasca et al. studied the magnetic activity and differential rotation of a typical young star, and found that its feature is also similar to the Sun[8]. Wichmann et al. found a fair amount of super flares in the Sun-like stars, and the common features of these stars are the young age and small rotation period[9]. Nogami et al. found that the rotation periods of some Sun-like stars producing super flares are similar to that of the Sun, in addition, they are more similar to one another in the aspects of effective temperature, surface gravity, and metal content[10].

However, the studies in above references were mainly based on the LC (Long Cadence) data selected from the Kepler data to perform a statistical analysis on super flares or the study on individual stars. The Kepler data are divided into the LC (Long Cadence) and SC (Short Cadence) data according to the time resolution[1]. The statistical analysis on the features of light curve profiles of stellar flares based on the SC data is a new study. The SC data will be selected from the data obtained by the Kepler space telescope for the analysis of this paper, in order to find the characteristic parameters of light curve profiles of Sun-like star flares by a statistical study, and to summarize the activity features of flares. In Section 2, we mainly introduce the origin and characteristics of data; and followed by Section 3, in which we describe the method of data analysis, analyze the features of light curve profiles of stellar flares, and obtain a preliminary result; finally, we make a physical analysis and discussion on the obtained result.

## 2. ORIGIN OF DATA

The advantage of Kepler space telescope for the observation of Sun-like star flares is the great amount of observed data of stars. The Kepler space telescope operated on the Earth-trailing heliocentric orbit was launched in 2009 for accurately detecting the Earth-like planets suitable for human life among the Sun-like stars by using the transit photometry method[1]. Only one photometer is carried by the Kepler, mainly for the measurement of stellar luminosity, to obtain the data of light curves of stars. The observed wavelength range is about 420∼900 nm[1], which mainly belongs to the visible light band, thus only capable for observing the white light flares. The key component of the Kepler photometer is composed of 42 scientific CCDs. The single exposure time of CCDs is 6.2 s, and the time of readout is 0.52 s[1]. In the detecting process, the CCDs are continuously exposed to give rise to a great amount of data, which have to be integrated and overlapped before transmitting to