A Brief Overview of the Palomar Transient Factory (PTF) and Recent Progress of PTF-RRL Program at the National Central University

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The Palomar Transient Factory (PTF) and its successor, the intermediate-PTF (iPTF), are wide-field synoptic surveying projects aimed to explore the transient universe. The time-series data from PTF/iPTF can also be used for asteroids and variable star research. The PTF/iPTF projects utilized the 48-inch Samuel Oschin Telescope located at the Palomar Observatory to carry out the surveys, which was equipped with the CFH12K CCD. This mosaic CCD has a pixel scale of $1.01''$ per pixel, resulting in a field-of-view of ~ 7.2 degree squared. With an exposure time of 60 seconds, the PTF/iPTF can reach to a depth of $R \sim 20$ mag, suitable to search for RR Lyrae stars (RRLs) located in the Galactic halo. At the Graduate Institution of Astronomy of the National Central University (IANCU), we are interested in using RRLs found in PTF/iPTF data for various scientific investigations, including the Galactic halo sub-structures. In this presentation, we report the recent progress of our PTF-RRL program, including the derivation of metallicity-light curve relation in the native PTF/iPTF R-band filter. Our relation can be immediately applied to distant RRLs and estimate their metallicity based on the PTF/iPTF light curves.

1 Introduction

The PTF project (2009–2012, Law et al., 2009; Rau et al., 2009) and the iPTF project (2013–2017) are dedicated time domain survey projects aimed to explore various types of transients. Both PTF and iPTF (or collectively referred as PTF/iPTF) use the same hardware, the 48-inch Samuel Oschin Telescope (also known as P48) equipped with the mosaic CFH12k CCD (which has eleven active $2\text{k} \times 4\text{k}$ CCDs, one CCD is out of function at the beginning of PTF survey), and software (i.e. the reduction pipelines hosted at IPAC), but with different scientific goals and international consortium members. PTF/iPTF observations were mainly done with a Mould-R filter (referred to as $R_{\rm PTF}$). Time-series data from the PTF/iPTF observations were not only being used in transients studies, but also in other areas such as asteroids and variable stars. To fully exploit the time-series data gathered in the PTF/iPTF surveys for variable star research, we have initiated a program, called PTF-RRL, aimed at studying RR Lyrae stars at our institution. The main goal of our PTF-RRL program is to *search, identify, and characterize RR Lyrae stars using*

PTF/iPTF data. We plan to construct light curves in $R_{\rm PTF}$-band for RR Lyrae stars that either have been identified before in the literature or those newly found in the PTF/iPTF data. A number of scientific topics can be explored with this set of RR Lyrae stars, one of such example is the investigation of the Galactic halo. The first task of our PTF-RRL program is to derive the photometric metallicity-light curve relation in the native $R_{\rm PTF}$-band, which is briefly discussed in Sect. 2. Our next and on-going task is to search for the new and/or faint RR Lyrae stars in a high cadence PTF field, which contains more than 6000 observations.

The iPTF project was terminated in early 2017, because a new mosaic CCD camera will be mounted on P48 for the next-generation PTF/iPTF survey – the Zwicky Transient Facility (ZTF). One of the major quantum leaps from PTF/iPTF to ZTF is that the dedicated CCD camera will provide a $\sim$47 degree-squared field-of-view, enabling an efficient synoptic survey of the sky with a rate of 3760 degree squared per hour (Bellm, 2014), or $\sim 3\pi$ sky in a night (assuming 8 hours per night). At the time of writing, ZTF is undergoing commissioning, and will begin the 3-year regular science operation in January 2018. Tools and experiences based on our PTF-RRL program will be directly applicable to ZTF for RR Lyrae star-related research.

2 The Metallicity-Light Curve Relation in PTF R-Band

The first task in our PTF-RRL program is deriving the metallicity-light curve relation (similar to the relation given in Jurcsik & Kovacs, 1996) for ab-type RR Lyrae stars in $R_{\rm PTF}$-band. This is because the metallicity, [Fe/H], is needed for RR Lyrae to derive their V-band absolute magnitude: $M_{\rm R} \sim M_{\rm V} = f([{\rm Fe/H}])$, the function f can be linear, piecewise, or quadratic. Based on the ab-type RR Lyrae in the *Kepler* Field with accurate [Fe/H] values derived from high-resolution spectroscopic observations (Nemec et al., 2013), we found that $[{\rm Fe/H}]_{\rm PTF} = -4.089 - 7.346P + 1.280\phi_{31}$, where P is pulsation period in days, and ϕ_{31} is one of the Fourier parameters describing the shape of RR Lyrae light curves. Further details of our work can be found in Ngeow et al. (2016).

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