Study Hubble constant anisotropies with the Zwicky Transient Facility

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The Zwicky Transient Facility (ZTF [1]) [1] at Mont Palomar Observatory (California, United States, see picture) has started its survey in early 2018, for six years. ZTF project consists of a new camera of about 600 million-pixels mounted on the Samuel Oschin 48-inch Schmidt telescope. The design offers a large field-of-view of 47 square-degrees. Combined with a high cadence of observation (exposure of 30 seconds) it allows to scan the full accessible sky in one night. With three optical filters corresponding to g, r and i bands, ZTF is able to perform a complete photometric survey of the northern sky in three night. All those features make this instrument a transient detection machine.

Mainly two kinds of transient are studied by ZTF [2]: (i) the moving objects of the solar system and (ii) phenomena of star explosion, like supernovæ (SNe). From the science point-of-view, Type Ia supernovæ (SNe Ia) are used to probe the Universe at cosmological scale. The goal of ZTF is to detect and study about $6,000$ SNe Ia to address cosmological questions of the nearby Universe in the redshift range $0.01 \lesssim z \lesssim 0.1$.

This new dataset of SNe Ia with its large statistic covering more than half of the full sky will allow to address new cosmological questions related to potential anisotropies in the nearby Universe.

The Standard Model of Cosmology is based on the cosmological principle, assuming the homogeneity and the isotropy of the Universe at large scale. The uniqueness of the ZTF SNe Ia sample allows for the first time to test the isotropy of the expansion rate, i.e. the Hubble constant H_0, in the nearby Universe.

The goal of the intership will be to use realistic ZTF simulation of SNe Ia to develop an anlysis of differential measurement of H_0 as a function of the sky direction with the aim of quantifying the sensitivity of the survey for such potential anisotropies. The work will be based on the ZTF simulation software (simsurvey) to generate the realistic SNe Ia light-curves and on the generic SNCOSMO software to characterize the light-curves in view of building an Hubble diagram. All codes are based on Python programmable language and its data analysis tools. The student must show interest in astronomy/astrophysics and data science.

[1] `https://www.ztf.caltech.edu`

References

[1] E.C. Bellm et al., *The Zwicky Transient Facility: System Overview, p-Performance, and First Results*, 2019, PASP, 131, 018002
https://iopscience.iop.org/article/10.1088/1538-3873/aaecbe

[2] M.J. Graham et al., *The Zwicky Transient Facility: Science Objectives*, 2019, PASP, 131, 078001
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