U23a Luminosity-Duration Relation of Fast Radio Bursts:a new tool for precision cosmology

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Nature of dark energy remains unknown. Especially, to constrain the time variability of the dark-energy, a new, standardisable candle that can reach more distant Universe has been awaited. Here we propose a new distance measure using fast radio bursts (FRBs), which are a new emerging population of $\sim$ ms time scale radio bursts that can reach high-z in quantity. We, for the first time, show an empirical positive correlation between the time-integrated luminosity (L_ν) and rest-frame intrinsic duration ($w_{\rm int,rest}$) of FRBs. The $L_\nu - w_{\rm int,rest}$ correlation is statistically very significant with >95% confidence level. This correlation can be used to measure intrinsic luminosity of FRBs from the observed $w_{\rm int,rest}$. By comparing the luminosity with observed flux, we measure luminosity distances to FRBs, and thereby construct the Hubble diagram. This FRB cosmology with the $L_\nu - w_{\rm int,rest}$ relation has several advantages over SNe Ia, Gamma-Ray Burst (GRB), and well-known FRB dispersion measure (DM)-z cosmology; (i) access to higher redshift Universe beyond the SNe Ia, (ii) high event rate that is $\sim$ 3 order of magnitude more frequent than GRBs, and (iii) it is free from the uncertainty from intergalactic electron density models, i.e., we can remove the largest uncertainty in the well-debated DM-z cosmology of FRB. Our simulation suggests that the $L_\nu - w_{\rm int,rest}$ relation provides tight constraints on the time variability of the dark energy when the next generation radio telescopes start to find FRBs in quantity.