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Anchors no more: Using peculiar velocities to constrain H0 and the primordial Universe without calibrators

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We develop a novel approach to constrain the Hubble parameter H_0 and the primordial power spectrum amplitude $A_{\rm s}$ using type Ia supernovae (SNIa) data. By considering SNIa as tracers of the peculiar velocity field, we can model their distance and their covariance as a function of cosmological parameters without the need of calibrators like Cepheids; this yields a new independent probe of the large-scale structure based on SNIa data without distance anchors. Crucially, we implement a differentiable pipeline in JAX, including efficient emulators and affine sampling, reducing inference time from years to hours on a single GPU. We first validate our method on mock datasets, demonstrating that we can constrain H_0 and $\log 10^{10} A_{\rm s}$ within 10% and 15%, respectively, using $\mathcal{O}(10^3)$ SNIa. We then test our pipeline with SNIa from an N-body simulation, obtaining 6%-level unbiased constraints on H_0 with a moderate noise level. We finally apply our method to Pantheon+ data, constraining H_0 at the 15% level without Cepheids when fixing $A_{\rm s}$ to its $Planck$ value. On the other hand, we obtain 20%-level constraints on $\log 10^{10} A_{\rm s}$ in agreement with $Planck$ when including Cepheids in the analysis. In light of upcoming observations of low redshift SNIa from the Zwicky Transient Facility and the Vera Rubin Legacy Survey of Space and Time, surveys for which our method will develop its full potential, we make our *veloce* code publicly available, and we will describe its features in detail.

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