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Comparing phantom dark energy models using statefinder diagnostic

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In our study, we used the statefinder diagnostic tool to analyze phantom dark energy (DE) models, specifically the big rip (BR), the little sibling of the big rip (LSBR), and the little rip (LR). We generate evolutionary trajectories of the statefinder $S_n(z)$ diagnostic using a Markov Chain Monte Carlo method and plot them based on the best fit extracted from each model. Our results demonstrate that, in the high-redshift region, the phantom DE models exhibit strong degeneracy with each other and the ΛCDM model, even with different parameter values. However, this degeneracy is broken in the low-redshift region through the use of $S_3^{(1)}$ and $S_4^{(1)}$ diagnostics. Furthermore, we observe that the statefinder diagnostic tool reveals the diverse behavior of the LSBR model, which can take on quintessence-like or phantom-like qualities depending on the Ω_{lsbr} parameter. In contrast, the LR model is only phantom-like. We also perform a direct comparison of the phantom DE models using the $\left\{ S_3^{(1)}, S_4^{(1)} \right\}$ and $\left\{ S_3^{(1)}, S_3^{(2)} \right\}$ planes and demonstrate that the separation between the models is visible at the current state of the models. Overall, we find that the statefinder diagnostic tool is robust in distinguishing between different DE models and even models of the same type with different equation of state (EoS), which ultimately lead to different outcomes for the fate of the Universe.

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