Kashiwa-no-ha park next to Kavli IPMU

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Bouncing Universe from Nothing

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We find a class of solutions for a homogeneous and isotropic universe in which the initially expanding universe stops expanding, experiences contraction, and then expands again (the "bounce"), in the framework of Einstein gravity with a real scalar field without violating the null energy condition nor encountering any singularities. Two essential ingredients for the bouncing universe are the positive spatial curvature and the scalar potential which becomes flatter at large field values. Depending on the initial condition, either the positive curvature or the negative potential stops the cosmic expansion and begins the contraction phase. The flat potential plays a crucial role in triggering the bounce. After the bounce, the flat potential naturally allows the universe to enter the slow-roll inflation regime, thereby making the bouncing universe compatible with observations. If the e-folding of the subsequent inflation is just enough, a positive spatial curvature may be found in the future observations. Our scenario nicely fits with the creation of the universe from nothing, which leads to the homogeneous and isotropic universe with positive curvature. As a variant of the mechanism, we also find solutions representing a cyclic universe.

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