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Modern Computational Approaches to Early Universe Modeling

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In physics, while analytical calculations remain appealing, there are situations where the use of computers becomes indispensable. A straightforward example is the three-body problem, where even the interactions of just three bodies are challenging to solve analytically. This necessity is similarly evident in studies of the early universe. Understanding the dynamics of the inflaton requires numerical analysis through lattice simulations in this context. Accessing high-performance computing (HPC) used to be difficult, but it is now widely available and significantly more powerful. We apply numerical results obtained through HPC to various physical problems, including the dark matter problem. However, practical constraints still hinder our ability to fully simulate the early universe, so we are exploring machine learning as a means to overcome these challenges.

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