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Inflation, primordial black holes and induced gravitational waves from modified supergravity

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Abstract: Modified (Starobinsky type) supergravity is used for a viable (unified) description of cosmological inflation and formation of primordial black holes and dark matter in the early Universe. A specific class of models is proposed and investigated in detail. Their observational predictions for primordial black hole masses, dark matter and induced gravitational waves are derived and compared to the current and future astrophysical and cosmological observations. Our approach naturally leads to the two-scalar-field attractor-type double inflation, whose first stage is driven by Starobinsky scalaron and whose second stage is driven by another scalar field which belongs to a supergravity multiplet. The scalar potential and the kinetic terms are derived, the vacua are studied, and the inflationary dynamics of those two scalars is investigated. We numerically compute the power spectra and find the ultra-slow-roll regime leading to an enhancement (peak) in the scalar power spectrum. This leads to an efficient formation of primordial black holes. We estimate their masses and find their density fraction as part of dark matter. We show that our modified supergravity models are in agreement with inflationary observables, while they predict the primordial black holes masses in the range between 10^{16} g and 10^{20} g. In this sense, modified supergravity provides a natural top-down approach for explaining and unifying the origin of inflation and the dark matter in the form of primordial black holes.

Keywords: inflation, primordial black holes, dark matter, supergravity

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Appendix A

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data is shown in the main text can be added here if brief, or as Supplementary data. Mathematical proofs of results not central to the paper can be added as an appendix.

Appendix B

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References

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