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Decaying Massive Scalar in Expanding FRW-universes

Particle decay processes in the early Universe have deep and profound implications in cosmology. In a regime where curvature cannot be neglected anymore, the Minkowskian quantum field theory is ultimately only an approximation and of limited applicability. Because the energy conservation law is violated, the particle decay rates, cross sections and lifetimes are modified compared to usual flat space results. New particle processes, forbidden in Minkowski space, are to be considered leading to new Feynman diagrams even at first order.

Using quantum field theory in curved spacetime, we calculate the transition probabilities for a massive scalar decaying into massless fermions and into massless scalars. This is done using the method of added-up probability. It is found that the usual Minkowskian decay rates are considerably modified for early times and in long-time limit approach the Minkowskian result. For conformally coupled scalars the decay rate is modified by an additive term and the decay into fermionic channel is enchanced and decay into scalar channel diminished. Comparisons of the decay rates show that a decay channel into fermions is the dominant channel of decay in the very early Universe.

Based on:

J. Lankinen and I. Vilja, Particle decay in expanding Friedmann-Robertson-Walker universes, Phys. Rev. D 98, 045010, arXiv:1805.09620

J. Lankinen, J. Malmi and I. Vilja, Fermionic decay of a massive scalar in the early Universe, arXiv:1904.05084

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