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## Axion-pion scattering at finite temperature in chiral perturbation theory and its influence in axion thermalization

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Axion-pion scattering amplitudes at finite temperatures are calculated within SU(2) chiral perturbation theory up to one loop level. Unitarization procedure is implemented to these amplitudes in order to extend the applicable range of energy and temperature. The influence of the thermal axion-pion scattering amplitudes on the  $a\pi \to \pi\pi$  cross sections and the axion thermalization rate is investigated, with the emphasis on the comparison with the zero-temperature-amplitude case. A brief discussion on the cosmological implication of the axion thermalization rate, that is calculated by using the  $a\pi \to \pi\pi$  amplitudes at finite temperatures, is also given. The thermal corrections to the axion-pion scattering amplitudes can cause around a 10% shift of the determination of the axion decay constant  $f_a$  and its mass  $m_a$ , comparing with the results by using the  $a\pi \to \pi\pi$  amplitudes at zero temperature.

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