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Impact of local CP-odd domain in hot QCD on axionic domain-wall interpretation for NANOGrav 15-year Data

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We argue that the axionic domain-wall with a QCD bias may be incompatible with the NANOGrav 15-year data on a stochastic gravitational wave (GW) background, when the domain wall network collapses in the hot-QCD induced local CP-odd domain. This is due to the drastic suppression of the QCD bias set by the QCD topological susceptibility in the presence of the CP-odd domain with nonzero θ parameter of order one which the QCD sphaleron could generate. We quantify the effect on the GW signals by working on a low-energy effective model of Nambu-Jona-Lasinio type in the mean field approximation. We find that only at $\theta = \pi$, the QCD bias tends to get significantly large enough due to the criticality of the thermal CP restoration, which would, however, give too big signal strengths to be consistent with the NANOGrav 15-year data and would also be subject to the strength of the phase transition at the criticality.

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