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Constraints on primordial black holes from interstellar dust temperature

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Interest in primordial black holes (PBHs) has strongly increased after the recent LIGO detection of gravitational waves from merging black holes. It is especially interesting that the intrinsic rotational momentum of these black holes is close to zero, which is difficult to explain for astrophysical black holes, but turns out to be quite logical for PBHs. Also, it is interesting that masses of merging black holes have appeared much more than masses of black holes obtained from other observational data. In addition, the question as to what is the dark matter is still unresolved. It is also worth noting that the cosmological properties of PBHs are similar to those of cold dark matter. Therefore, PBHs can be considered as a candidate for the role of dark matter.

In this paper we calculate constraints on PBHs for different distributions of PMHs with masses 10^{15} – 10^{17} g, with photons emitted by these PBHs due to the Hawking effect interacting with interstellar dust. We consider a model in which PBHs are homogeneously distributed in the Universe and the dust particles are homogeneously distributed in our Galaxy. This method of finding constraints on PBHs has been proposed for the first time and has not been considered before.

A photon emitted by a PBH is absorbed by a dust particle and drives the dust particles in a thermal motion. The dust particle absorbs photons with energies at all wavelengths, heats up and begins to emit in a continuous spectrum, which can be approximated by the Planck spectrum. The equilibrium dust temperature T_d for the graphite and silicate components is determined from the heat balance condition. Radiation from other sources is not taken into account when calculating the dust heating rate. As a model of interstellar dust the MRN model was chosen, according to which the interstellar dust particles have a spherical shape and consist of a mixture of silicate and graphite particles in approximately equal mass proportions. The particle sizes are $0.005 < a < 0.25$ μm, and their size distribution has a power law character, $n(a) \sim a^{-3.5}$.

We consider lognormal and monochromatic mass distribution of PBHs. We calculate dust heating rate and dust cooling rate for graphite and silicate dust grains. Then we compare dust heating rate and dust cooling rate assuming that the heating rate should be less than the cooling rate and calculate constraints on PBHs. We are compare received constraints with constraints obtained in the previous works for the extragalactic and Galactic background. As a result, for the monochromatic mass function the restrictions obtained in this paper are weaker than in the previous works. For the lognormal mass distribution the restrictions were more strict than in the two works with which the results were compared, but less strict than in the third work at the value of the lognormal distribution parameter $\sigma = 2$.

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