

## Spanish and Portuguese Relativity Meeting



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# Primordial black hole formation from a nonspherical density profile with a misaligned deformation tensor

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We perform the numerical simulation of primordial black hole formation from a nonspherical profile of the initial curvature perturbation  $\zeta$ . We consider the background expanding universe filled with the perfect fluid with the linear equation of state  $p = w\rho$  ( $w = 1/3$  or  $1/5$ ), where  $p$  and  $\rho$  are the pressure and the energy density, respectively. The initial condition is set in a way such that the principal directions of the second derivatives of  $\zeta$  and  $\Delta\zeta$  at the central peak are misaligned, where  $\Delta$  is the Laplacian. In this setting, since the linearized density is proportional to  $\Delta\zeta$ , the inertia tensor and deformation tensor  $\partial_i\partial_j\zeta$  are misaligned. Thus tidal torque may act and the spin of a resultant primordial black hole would be non-zero in general, although it is estimated to be very small from previous perturbative analyses. As a result, we do not find a finite value of the spin within our numerical precision, giving support for the negligibly small value of the black hole spin for  $1/5$

*lessimw*

*lessim1/3*. More specifically, our results suggest that the dimensionless PBH spin  $s$  is typically so small that  $s \ll 0.1$  for  $w$

*gtrsim0.2*.

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