Role of non-commutative geometry in gravitational collapse scenarios

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Abstract: The collapse process of a homogeneous scalar field has been studied by many authors and it has been shown that such a process would end in a curvature singularity which can be either hidden behind a horizon or be visible to external observers. In the present work, we revisit the collapse process of a spherically symmetric homogeneous scalar field (in FRW background) minimally coupled to gravity, when the phase-space deformations are taken into account. Such a deformation is mathematically introduced as a particular type of noncommutativity between the canonical momenta of the scale factor and of the scalar field. In the absence of such deformation, the collapse culminates in a spacetime singularity. However, when the phase-space is deformed, we find that the singularity is removed by a non-singular bounce, beyond which the collapsing cloud re-expands to infinity. More precisely, for negative values of the deformation parameter, we identify the emergence of a negative pressure term, which slows down the collapse to finally avoid the singularity formation. Depending on the model parameters, one can find a minimum value for the boundary of the collapsing cloud or correspondingly a threshold value for the mass content below which no horizon would form. Such a setting predicts a threshold mass for black hole formation in stellar collapse and manifests the role of non-commutative geometry in physics and especially in stellar collapse and supernova explosion. [1–3].

Keywords: gravitational collapse, non-commutative geometry, non-linear differential equations, numerical method

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