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Spiral Arms In Gaseous Discs Driven By Different Mechanisms

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In order to investigate features of spiral arms induced by different mechanisms within gaseous discs, we have adapted PHANTOM, a suite of code based on smoothed particle hydrodynamics in Fortran, to simulate various types of galactic potentials with the power of XC50. Those potential are an evolving triaxial dark matter halo, density wave theory, bar potential and tidal interaction. All simulations were conducted as Milky Way like galaxies in isothermal context with a resolution of 10^5 at a temperature of 10^3 K.

Evolving in different ways characterized by time and switch-on function, the triaxial dark matter halo potential grows from a pure spherical shape into an prolate type ellipsoid. We have found the grand two-armed spirals could be developed as the triaxiality of halo turns on gradually unless the process of increasing the triaxiality of halo is adiabatic enough. With a fully adiabatic growth, spirals are not necessarily induced. The potential we adapted for density wave mechanism is Cox&Gomez arm potential with winding and strength control terms by following the precious literatures. We found that spurs structures, which is common in original original Cox&Gomez potential do not appear when we implement the corotating and winding terms. Furthermore, we also observed dominating mode of spirals quantized by Fourier analysis is 2 throughout the whole process, which is in contrast with the that m could evolve to 4 after a period of time in the outer area of the disc in the case of original Cox&Gomez arms. Spirals generated by triaxial dark matter halos are obviously more long-standing than those by revised Cox&Gomez potential. The bar potential is described and controlled by a quadrupole potential featured by its characteristic lengths. Weak but perpetual two-armed spirals could be generated at the each end of the bar in the central disc. With the same approach but reductions in the size and strength as a function of time for the bar potential by following the past studies, we framed the potential of the tidal component flying-by the disc. Not surprising, strong grand two-armed spirals would be tidally induced through the process that the gaseous disc encounters the approaching component and these arms could disappear immediately as the component flies away.

Also we have coded an initial column density for the disc in the form of exponential in Phantom, which is more realistic for galaxies in our world. However this is also a double-sided sword since exponential brings up a higher concentration in central area of the galaxy that might leads to much longer simulation run time.

In the future, we will continue to quantitatively inspect the spiral features such as pattern speed, spiral strength, pitch angles and lifespan of spirals induced under those various mechanisms by utilizing Fourier decomposition with error analysis in a higher resolution above 10^6 as well as put cooling process into consideration. Hopefully, we could compare those four mechanisms systematically and provide clues in astronomical observations.