TWO-DIMENSIONAL CALCULATIONS OF TIGHTLY WOUND SPIRAL SHOCKS

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Recently it has been possible to perform computer calculations with sufficiently high resolution to obtain the response of the gas in galaxies to a tightly wound spiral potential due to a stellar density wave. Previously for pitch angles $\sim 10^{o}$ the problem had to be simplified using the tightly wound approximation, with gradients parallel to the arms neglected compared to perpendicular gradients, yielding a quasi-1-dimensional calculation. This paper reports the early results of a 2-dimensional calculation, and compares them with the 1-dimensional results.

The calculation was performed on an ICL Distributed Array Processor at QMC, London, allowing a polar grid of dimensions 63x126 in r and θ. The gas was initially in circular motion with uniform density, and a two-armed trailing spiral potential was switched on slowly over a few mean rotation periods. The response was then followed for up to 10 such periods, and the figure shows the response at a time of 3×10^{9} years for a pitch angle of 20^{o}, and a perturbing potential amplitude of 3%. The figure shows the density profile in azimuth across a single arm at varying galactic radii, with the arm unwound for clarity. The position of corotation at 22 kpc is indicated by the arrow. Inside corotation there is an inner shock on the left edge of the arm (rotation is from left to right), while outside corotation there is an outer shock on the right hand edge as expected. In between, at around corotation, the density response is hardly diminished and the width of the arm is as narrow as it is away from corotation.

These results are in contrast to previous quasi-1-dimensional results, in which the density amplitude decreases markedly at corotation and the width of the peak widens to a broad bump (see Nelson and Matsuda, 1977); while away from corotation the density peak is very narrow compared to that shown here. It seems therefore that the 1-dimensional tightly wound approximation has a tendency to artificially broaden the density peak at corotation, and to make it sharper elsewhere.

H. van Woerden et al. (eds.), The Milky Way Galaxy, 533–534.

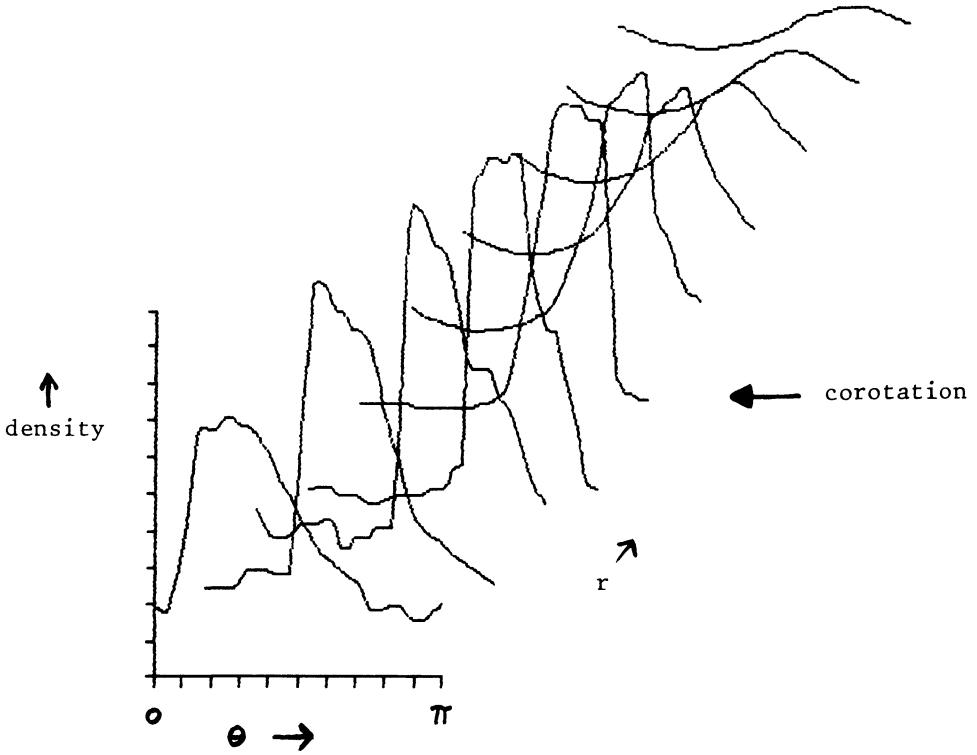

Figure 1. Density profiles in azimuth at various radii. Only one spiral arm is shown, and it has been unwound for clarity. The profiles start at a radius of 7 kpc and go outwards in steps of 3.5 kpc to 38.5 kpc.

REFERENCE

Nelson, A.H. and Matsuda, T.: 1977, M.N.R.A.S. 179, 663

https://doi.org/10.1017/S0074180900243064 Published online by Cambridge University Press