ON THE USE OF THE WKBJ DENSITY WAVE THEORY AT THE INNER LINDBLAD RESONANCE REGION OF OUR GALAXY

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I have tested the reliability of certain approximations involved in the asymptotic WKBJ density wave description of the inner Lindblad resonance (=ILR) of our galaxy.

To calculate the induced density one has to integrate along the orbit of the star. Since this is difficult to do exactly, epicyclic orbits and series expansions are used instead. This necessarily introduces the problem of ordering the small parameters involved and, after such an ordering has been adopted, the neglect of higher order terms. At the ILR such higher order terms include the azimuthal dependance of the potential and the derivatives of the wavenumber. It would be desirable to know the errors thus introduced.

I have done so using the integral equation for the reduced potential, which does not rely on the above mentioned approximations and does not introduce any further approximations not included in the WKBJ treatment. The test is in no way complete since it does not raise either the question of nonlinearity, or of how adequate a description of real orbits epicycles can be, since the integral equation is linear and uses epicycles. Also I have applied it only to the short waves.

For the trailing waves, in all cases tested so far, the error introduced by all other approximations except for the neglect of the azimuthal dependance of the potential, does not exceed 15-20%. If one includes this also, one reaches 30-40%. Unfortunately this does not hold for leading waves, where in all cases tested the error was larger than the solution itself. This result shows an inadequacy of the WKBJ resonant theory, at least in one example, and thus raises a doubt as to its unquestioned applicability.

DISCUSSION

Burton: Would you remind us of the observational data which you have in the back of your mind when you are thinking about the Inner Lindblad Resonance in our Galaxy.

W. B. Burton (ed.), The Large-Scale Characteristics of the Galaxy, 191–192.

Contopoulos: Near the Inner Lindblad Resonance the orbits are rather elongated along a certain direction, and the response density is also elongated. In a barred galaxy, like NGC 2950, the ILR should be near the maximum ellipticity of the isophotes, and this is supported by the fact that the 4θ-term is also maximum there. In the case of our Galaxy we also expect the orbits of stars (and the streamlines of gas) to be most elongated near the ILR. This effect may produce a streaming along the 3-kpc arm. Thus there may also be an appreciable four-armed component in this region.

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