General Physics Seminar
Rijnhuizen Seminar Room

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Wave attractors due to symmetry breaking in stratified and/or rotating fluids

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An important aspect of Geophysical Fluid Dynamics is the study of stratified, rotating fluids in irregular domains. Both uniformly-stratified, as well as uniformly-rotating, homogeneous fluids support `internal' waves that propagate energy obliquely through the fluid. For a given fixed frequency, this direction with respect to gravity, or rotation axis is fixed. This implies that sloping boundaries, breaking the symmetry of energy paths, focus these internal gravity, or inertial waves upon `wave attractors' (1): `hotspots' of wave energy, where, regardless of initial generation site, waves of a particular frequency will be directed to. Laboratory observations, presented here, confirm this (2,3). In the rotating fluid experiment, dye-spreading suggests that the mixing that results upon focusing of the inertial waves, generates a cyclonic mean flow. Applied to rotating, radially-stratified spherical shells, in which the direction of gravity and rotation axis are not aligned, the accessible domain for wave propagation is restricted by the appearance of turning surfaces. Yet, wave attractors still occur, suggesting them to be relevant for the generation of zonal (equatorial) currents and so-called inertial oscillations.

Considering the analogy between Lorenz force and Coriolis force, one wonders whether wave attractors may perhaps appear in plasmas too.

Refs:

1 Maas, L.R.M. and Lam, F.-P. A., 1995. Geometric focusing of internal waves. Journal of Fluid Mechanics, 300, pp. 1-41

2 Maas, L.R.M., D. Benielli, J. Sommeria and F-P. A. Lam, 1997. Observation of an internal wave attractor in a confined stably-stratified fluid. Nature, 388, pp. 557-561

3 Maas, L.R.M., 2001. Wave focusing and ensuing mean flow due to symmetry breaking in rotating fluids. Journal of Fluid Mechanics, 437, 13-28