# Computation of the normal form near a triple +1 bifurcation of a periodic orbit in a large scale $O(2)$ equivariant system.

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**Abstract**

The normal form close to a multi-critical bifurcation point of a periodic orbit with $D_4$ symmetry in a two-dimensional thermal convection problem is derived. Their coefficients are determined numerically by perturbing the initial solution and applying solvability conditions. The symmetry properties of the eigenfunctions, obtained in the numerical linear stability analysis of the symmetric periodic orbits, allow to anticipate the appropriate expansion for the solutions close to the bifurcation, and simplify the recursive set of non-homogeneous linear equations that involve the coefficients. These equations have periodic solutions if their forcing terms are orthogonal to four linearly independent eigenfunctions of the adjoint problem.

The calculation of the normal form coefficients implies the computation of stable and unstable periodic orbits and their stability, and the computation of the periodic orbits of an adjoint problem. The methods employed are described in [1].

## References

[1] J. Sánchez, M. Net, B. García-Archilla and C. Simó. Newton-Krylov continuation of periodic orbits for Navier-Stokes flows. *J. Comput. Phys.*, 201, 2004.