Analysis of direct and parametric excitation with the Melnikov method and the technique of basin erosion.

Y-M Scolan, ESIM, 13451 Marseille cedex 20, France, scolan@esim.fr

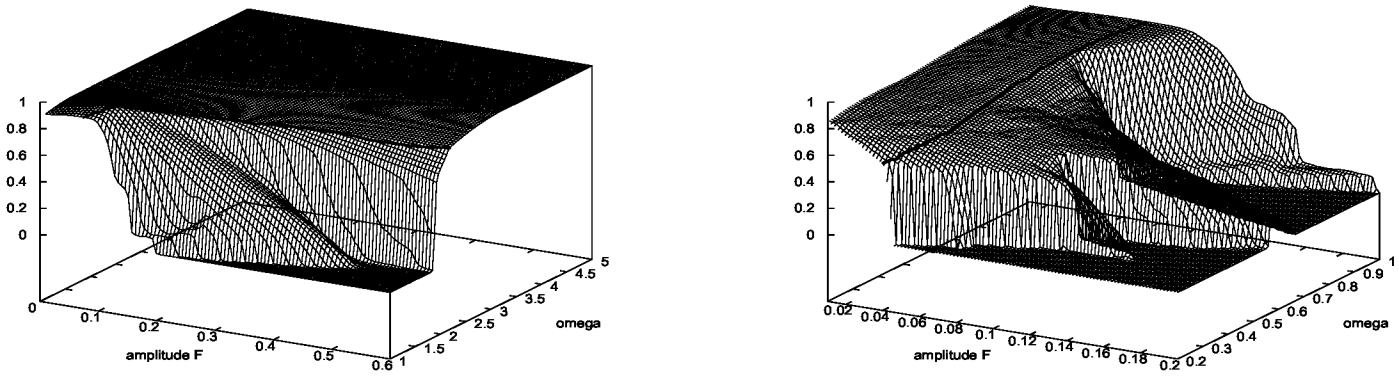
Solutions of nonlinear Mathieu equations are analyzed through two methods: Melnikov method and the technique of basin erosion. A differential equation is formulated for a single degree of freedom. The coupling with another degree of freedom appears parametrically. The way to formulate the equation is similar to the way exposed in Thompson *et al.* (1992). Concerning the rolling motion of ships these circumstances occur when the influence of the wave slope on the restoring can be taken into account.

Here the Melnikov function is calculated and analyzed. Then the space of parameters can be separated into "safe" and "unsafe" areas. The obtained results are compared to optimized numerical direct simulations. The Interpolated Cell Mapping is used (see Tongue and Gu 1988).

As an application the following differential equation is analyzed:

$$\ddot{x} + \beta(\dot{x}) + x(1-x)\Big[1 + G\cos(\omega t + \psi)\Big] = F\sin\omega t \qquad (1)$$

where G and F are the amplitudes of the direct and parametric forcing excitations linked by $F = G\omega^2$. The quantity ω is the ratio of the wave frequency to the natural frequency of the ship (linear) rolling motion. The erosion of the basin of attraction is described in the space of parameters (F,ω). The figure below shows a typical "Dover cliff" limited by a plain line predicted by the Melnikov method. The figure on the right is a zoom for small values of (F,ω).



Thompson J.M.T., Rainey R.C.T. & Soliman M.S., 1992, "Mechanics of ship capsize under direct and parametric wave excitation.", Phil. Trans. R. Soc. Lond. A 338, pp 471-490.

Tongue B.H. & Gu K., 1988, "A higher order method of interpolated cell mapping.", J. of Sound and Vibration, 125(1), pp 169–179.