Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Resonantly Forced Gravity–Capillary Lumps on Deep Water[1]

T.R. AKYLAS, YEUNWOO CHO, MIT — A theoretical study is made of the wave disturbance generated by a locally confined external pressure on the surface of deep water moving with speed V near the minimum gravity–capillary phase speed, c_{min}. According to linear inviscid theory, the response when V coincides with c_{min} is unbounded, and the interplay of nonlinear and damping effects is crucial close to this resonance. The analysis is based on an approximate model that combines the linear dispersion relation in the vicinity of c_{min} with quadratic and cubic nonlinearity as well as viscous damping. For V well below c_{min}, the transient response from rest approaches the small-amplitude steady state predicted by linear theory, but nonlinear effects come into play at a certain forcing speed, $c_{crit} < V$. Past this critical speed, that depends on the strength of the forcing, the response jumps to a finite-amplitude state comprising a gravity-capillary lump on the downstream side of the excitation, and a time periodic state is also possible for a range of forcing speeds slightly below c_{min}. This latter state involves periodic shedding of lumps that get damped quickly as they propagate downstream of the forcing. The theoretical predictions show good qualitative agreement with laboratory experiments conducted by J. H. Duncan and J. Diorio at U. of Maryland.

[1]Supported by NSF and AFOSR.

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Date submitted: 07 Jul 2009

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