Chaos in foams with grains

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We have observed some features of foams and granular materials in Hele-Shaw cells. When a liquid containing a surfactant is shaken in the presence of air, there is the formation of a foam by the action of deformation and stretching of the air/liquid interface. If this foam is left to rest, the interface evolves towards a minimal surface by a minimization process of energy. If the motion persists, the liquid flows through the interstitial spaces between bubbles, along with the rearrangement of the bubble structure. We consider the following question: what are the descriptions from the point of view of dynamical systems theory applicable to the complex spatio-temporal behavior of the foam evolution? We have described the stretching and folding mechanism present in foams obtained from an experiment of a Hele-Shaw cell containing liquid detergent and air [1]. We have reported the evolution of liquid and air for some sequences of upside-down flips, with a detailed description of the phenomenology involved, such as the snowball effect and vertex creation. We also have found that the general evolution of the foam in the presence of the granular material is different from the case without grains, while the foam structure in the stationary state in both cases is almost the same, with their fractal dimensions close to the values obtained from Random Apollonian Packing. Our results indicate that granular materials can alter some aspects of pattern formation in foams, such as the emergence of nodes with degree four. This work was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and Instituto Nacional de Ciência e Tecnologia de Fluidos Complexos (INCT-FCx). [1] A. Tufaile, A. P. B. Tufaile, Stretching and folding mechanism in foams, Physics Letters A 372, (2008) 6381-6385. [2] A. Tufaile, A. P. B. Tufaile, T. A. S. Haddad, Mixing foams and grains in Hele-Shaw cells, Journal of Physics, accepted for publication.