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Solving the riddle of the snow globe

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Credit: Tel Aviv University

If you've shaken a snow globe, you've enjoyed watching its tiny particles slowly sink to the bottom. But do all small objects drift the same way and at the same pace?

A new Tel Aviv University study finds the sedimentation of asymmetric objects in liquid is very different from that of symmetrical objects like spheres. The research solves a long-standing puzzle concerning the cause and the extent of "storminess" in sedimentation, and may be useful in improving water treatment and industrial processes that rely on suspensions, which are liquids that contain small solid particles. The research may also have use in the study of geological deposits, because variations in the concentration of particles from place to place affect the progress of sedimentation.

The research was led by Prof. Haim Diamant of TAU's School of Chemistry in collaboration with Prof. Thomas Witten of the University of Chicago, and conducted by TAU doctoral student Tomer Goldfriend. It was sponsored by the US-Israel Binational Science Foundation (BSF) and published in *Physical Review Letters*.

The calm and the storm

"Our research clarifies a common, complex phenomenon and offers ways of controlling it," Prof. Diamant said. "We have demonstrated that the 'storminess' of sedimentation is specific to symmetrical objects such as spheres and ellipsoids. It disappears in the more general case of asymmetric objects, which can have arbitrary shapes. Asymmetric objects render the sedimentation process more uniform and less chaotic."

Certain chemical reactors and water-treatment facilities rely on processes closely related to sedimentation, Prof. Diamant explained. "These are called 'fluidized beds,' where settling particles are made to hover in the liquid by an opposing upward flow of liquid, which facilitates their chemical activity. Fluidized beds are used in the production of polymers such as rubber and polyethylene. They are also used to improve the efficiency of water and waste treatment facilities. Our work might lead to improvements of such processes by controlling the uniformity of particles distributed in the liquid."

The team is currently studying the organizational properties of other kinds of materials. "We now intend to look for physical scenarios other than sedimentation that may show a similar kind of 'self-taming'—that is, a tendency of the material's constituents to self-organize into extremely uniform configurations," Prof. Diamant said. "The basic question is whether the behavior that we have found is unique to the process of sedimentation or can be found in a much broader class of materials. We think—we hope—that the latter is true."

More information: Tomer Goldfriend et al, Screening, Hyperuniformity, and Instability in the Sedimentation of Irregular Objects, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.158005

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