Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Paperfuge: An ultralow-cost, hand-powered paper-centrifuge inspired by the mechanics of a whirligig toy M. SAAD BHAMLA, Stanford University, BRANDON BENSON, CHEW CHAI, MIT, GEORGIOS KATSIKIS, AANCHAL JOHRI, MANU PRAKASH, Stanford University — From a global-health context, commercial centrifuges are expensive, bulky and electricity-powered, and thus constitute a critical bottleneck in the development of decentralized, battery-free-point-of-care (POC) diagnostic devices. Here, we report an ultralow-cost (20 cents), lightweight (2 g), human-powered paper centrifuge (which we name 'paperfuge') designed on the basis of a theoretical model inspired by the fundamental mechanics of an ancient whirligig (or buzzer toy; 3300 B.C.E). The paperfuge achieves speeds of 125,000 rpm (and equivalent centrifugal forces of 30,000 g), with theoretical limits predicting one million rpm. We demonstrate that the paperfuge can separate pure plasma from whole blood in less than 1.5 minutes, and isolate malaria parasites in 15 minutes. We also show that paperfuge-like centrifugal microfluidic devices can be made of polymethylsiloxane, plastic and 3D-printed polymeric materials. Ultracheap, power-free centrifuges should open up opportunities for POC diagnostics in resource-poor settings.

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Date submitted: 11 Nov 2016 Electronic form version 1.4