Response to Asif Equbal

Comments are in black, responses are in blue

I have two concerns regarding this draft.

1. Figure 4A shows that as the inner radius (r) in a sphere increases, the moment of inertia along Iz and Ix(or Iy) become unequal, with inertia along Iz being larger than Ix. The authors have used this fact to support the spinning-stability of sphere without groves. The moment of inertia of a sphere is proportional to the radius of sphere (R). Therefore, the absolute difference between the inertia in two directions (z and x) is also proportional to R. In the case presented, the sphere is large 9.5mm (with the maximum speed of~4-5 kHz), and therefore it has a preferred axis of rotation. But as one goes for smaller sphere to achieve faster spinning (which is a major goal here), the absolute difference between Iz and Ix will be smaller and smaller. And in such scenario, the spinning along any particular axis will not be stable.

All calculations were performed without using a fixed value for the radius. The results depicted in Figure 4 are valid for any given radius- note that the x-axis is "normalized inner radius," which takes into account the fact that these results scale for any outer radius value. It is true that the absolute values of the moments of inertia will decrease with smaller rotors, but the ratio of values between Iz and Ix will always be the same. The size of the rotor should not affect these stability considerations. For experimental proof of this, we have spun 4mm spherical rotors stably at 28 kHz, and 2mm rotors at around 60 kHz (unpublished).

2. The authors have compared two cases, a sphere vs. a cylinder in figure 4. Sphere(hollow one) has preference to spin along "z" and a cylinder along "x". Using this simple comparison, authors have shown why a sphere is better than cylinder for stability. In reality, the sample cup should be viewed as a combination of coaxial: (i). Spherical ring, (ii) a hollow cylinder (in which sample will be filled), (iii) a solid cylinder (basically the sample filled in the cylinder) and (iv) curved cap. Different components (i, ii, iii and iv) will have different inertia. These are known or at least easy to calculate. Since moments of inertia are additive, it is possible to do a more realistic calculation, taking into consideration moments of inertia of all these components.

To address this concern, as other reviewers have also noted interest in this issue, we have added as supplementary material an interactive Mathematica document which allows the reader to independently adjust the densities for the sample, caps, and rotor in order to see the effect on the moments of inertia as a function of normalized inner radius. We have added additional discussion on this topic to this document. The model we use is a simple approximation of how we pack sample into the rotors, but should give a sense for the effects of sample and cap density on the moments of inertia of the overall packed rotor.

Minor concern: Authors have used same notations to represent the dimensions of the two objects. It is better to use distinguished symbols to , e.g., r_s, R_s, r_c and R_c.

For the results to be compared between the sphere and cylinder for a given outer radius R and inner radius r, we have chosen not to demarcate these with distinguished symbols.