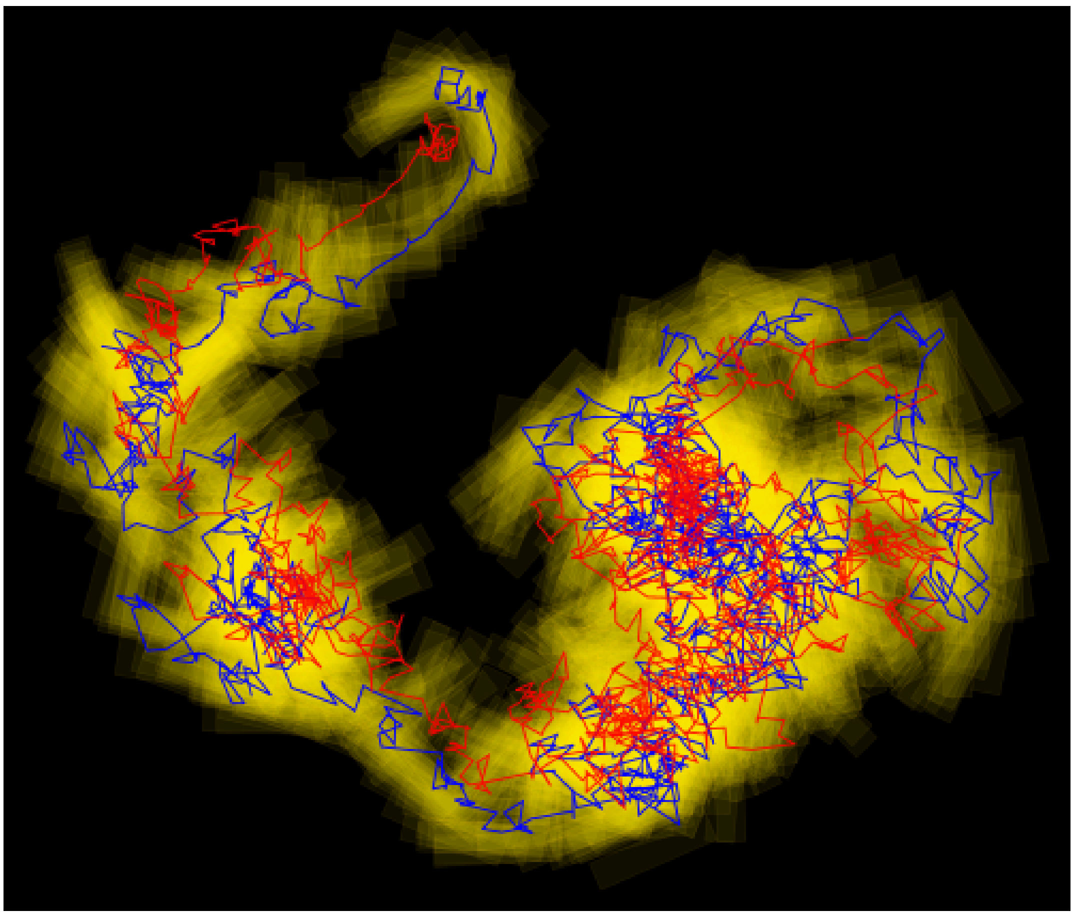
# Researchers find boomerang shaped colloid does not conform to Brownian motion

October 25 2013, by Bob Yirka



A trajectory of a boomerang particle in water, starting from the top of the image, with the blue line tracking the point where the arms meet and the red line tracking the "center of hydrodynamic stress," a point along the axis bisecting the angle of the arms. The boomerang itself is shown in yellow. Credit: A. Chakrabarty et al., Phys. Rev. Lett. (2013)

(Phys.org) —A team of researchers working at Kent State University in Ohio has found that a custom shaped colloid that resembles a boomerang does not conform to Brownian motion, at least in the short term. In their paper published in the journal *Physical Review Letters*, the team describes how they created their unique colloid and then tracked its movement though a liquid and found its mean displacement was not zero.

It was in 1905 that Albert Einstein suggested that spherical colloids (where tiny particles are suspended in a fluid) exhibit random movement due to interactions with the molecules that make up the liquid. He suggested that the distance a colloid traveled should be proportional to the square root of the amount of time that has passed. Also, because the colloid would move in a random direction from its starting point when placed in water the mean distance (displacement) it would travel would be zero (averaging a foot forward with a foot back gives zero distance traveled, for example). In this new effort the researchers found that creating a colloid in the shape of a boomerang caused it to behave in ways that don't conform to Einstein's theories.

Eager to find out if changing the shape of colloid could cause it to move with more predictability, the researchers created one (2.1 μm long by 0.51 μm thick) out of polymeric materials, doused it with water, then squished it between two glass plates, allowing only for movements in two dimensions. They then used video microscopy to track its movements.

In analyzing the video, the researchers found that for the first minute, the oddly shaped colloid did not move in a random direction, instead it moved in nearly a straight line along an axis bisecting the arms of the boomerang. After that, things became chaotic and the colloid moved randomly. But that first minute of predictability offers hope for creating colloids that might be useful—directing the motion of medicinal colloids, for example, or as part of an effort to create materials that are able to assemble themselves (something that would be very useful for long term space projects.)

The researchers report that they are not yet done studying their boomerang colloid—they next plan to see how it behaves when exposed to a magnetic or electric field. The hope is that doing so might allow for controlling its path for as long as desired.

**More information:** Brownian Motion of Boomerang Colloidal Particles, Phys. Rev. Lett. 111, 160603 (2013) [DOI: 10.1103/PhysRevLett.111.160603](https://doi.org/10.1103/PhysRevLett.111.160603)

**Abstract**
We investigate the Brownian motion of boomerang colloidal particles confined between two glass plates. Our experimental observations show that the mean displacements are biased towards the center of hydrodynamic stress (CoH), and that the mean-square displacements exhibit a crossover from short-time faster to long-time slower diffusion with the short-time diffusion coefficients dependent on the points used for tracking. A model based on Langevin theory elucidates that these behaviors are ascribed to the superposition of two diffusive modes: the ellipsoidal motion of the CoH and the rotational motion of the tracking point with respect to the CoH.