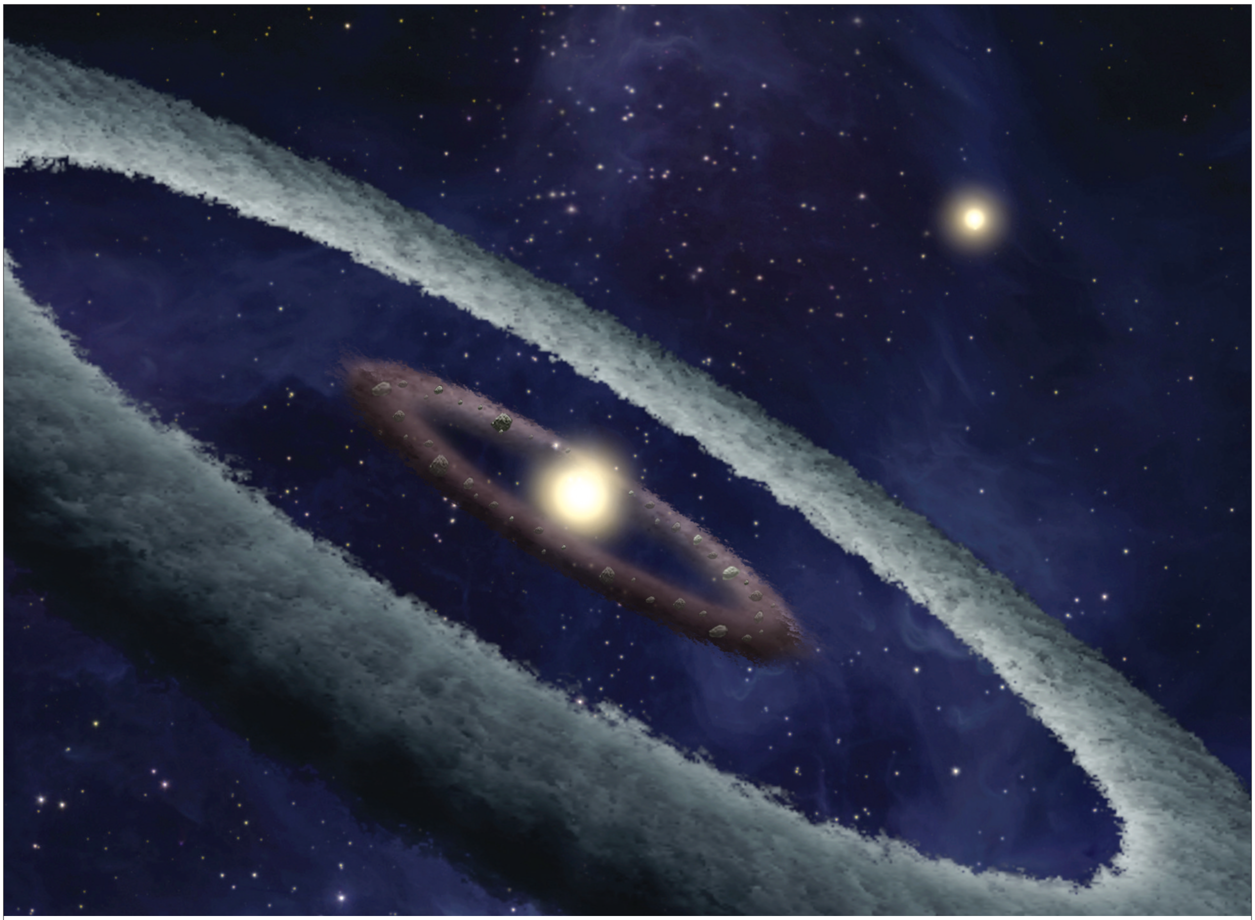

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Nano Fitness: Helping Enzymes Stay Active and Keep in Shape

Proteins are critically important to life and the human body. They are also among the most complex molecules in nature, and there is much we still don't know or understand about them.

One key challenge is the stability of enzymes, a particular type of protein that speeds up, or catalyzes, chemical reactions. Taken out of their natural environment in the cell or body, enzymes can quickly lose their shape and denature. Everyday examples of enzymes denaturing include milk going sour, or eggs turning solid when boiled.

Rensselaer Polytechnic Institute Professor Marc-Olivier Coppens has developed a new technique for boosting the stability of enzymes, making them useful under a much broader range of conditions. Coppens confined lysozyme and other enzymes inside carefully engineered nanoscale holes, or nanopores. Instead of denaturing, these embedded enzymes mostly retained their 3-D structure and exhibited a significant increase in activity.

"Normally, when you put an enzyme on a surface, its activity goes down. But in this study, we discovered that when we put enzymes in nanopores -- a highly controlled environment -- the enzymatic activity goes up dramatically," said Coppens, a Professor in the Department of Chemical and Biological Engineering at Rensselaer. "The enzymatic activity turns out to be very dependent on the local environment. This is very exciting."

Results of the study were published last month by the journal Physical Chemistry Chemical Physics.

Researchers at Rensselaer and elsewhere have made important discoveries by wrapping enzymes and other proteins around nanomaterials. While this immobilizes the enzyme and often results in high stability and novel properties, the enzyme's activity decreases as it loses its natural 3-D structure.

Coppens took a different approach, and inserted enzymes inside nanopores. Measuring only 3-4 nanometers (nm) in size, the enzyme lysozyme fits snugly into a nanoporous material with well-controlled pore size between 5 and 12 nm. Confined to this compact space, the enzymes have a much harder time unfolding or wiggling around, Coppens said.

The discovery raises many questions and opens up entirely new possibilities related to biology, chemistry, medicine, and nanoengineering, Coppens said. He envisions this technology could be adapted to better control nanoscale environments, as well as increase the activity and selectivity of different enzymes. Looking forward, Coppens and colleagues will employ molecular simulations, multiscale modeling methods, and physical experiments to better understand the fundamental mechanics of confining enzymes inside nanopores.

The study was co-authored by Lung-Ching Sang, a former Rensselaer Graduate Student in the Department of Chemical and Biological Engineering.

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Journal Reference: 1. Lung-Ching Sang, Marc-Olivier Coppens. Effects of surface curvature and surface chemistry on the structure and activity of proteins adsorbed in nanopores. Physical Chemistry Chemical Physics, 2011; 13 (14): 6689 DOI: 10.1039/C0CP02273J