Re-engineering a Centrifuge Force Microscope (CFM) to Enable the Study of Induced Crystal Nucleation in Hypergravity

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I aim to modify a preexisting centrifuge force microscopy (CFM) to explore protein crystallization under hypergravity. Proteins are involved in every aspect of cellular life, performing a variety of biological functions. Because of their crucial roles, proteins are involved in many disease processes making them common drug targets; some proteins are also used as therapeutics. The biological functions of proteins are largely informed by their three-dimensional (3D) structures. The 3D structure of a protein helps us understand its functions and mechanisms at a molecular level. The structure of a protein can be determined through a variety of methods. Among these methods, X-ray crystallography is the method that is most commonly used. This method, however, is limited by challenges in growing protein crystals. Here I have explored a new protein crystallization platform with CFM. CFM, a recently developed instrument, consists of a centrifuge producing an apparent centrifugal force and a microscope producing an image of the sample. Hypergravity condition generated by CFM allows concentrations needed for nucleation to be more quickly achieved. This setup also allowed me to monitor protein crystal nucleation and growth under the conditions of hypergravity in situ. To this end, a special chamber for protein crystallization along with other components to suitably modify the CFM, were designed, 3D printed and assembled. The effects of rotational speed and time were investigated. This proof-of-concept experiment explores a new method of protein crystallization, which might be beneficial for speeding up protein crystallization and inform on protein crystallization under hypergravity.