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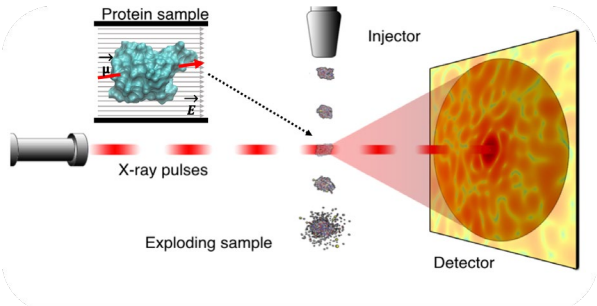
Single particle imaging at X-ray Free-Electron Lasers
The effect of controlling protein orientation using strong electric fields

Single particle imaging is a set of emerging techniques that utilize ultrashort and ultraintense X-ray pulses to generate diffraction from single isolated particles in the gas phase to determine their structures.
However, one of the main challenges of this approach is the unknown orientation of the individual sample molecules at the time of exposure, which makes structure determination computationally demanding and, in some cases, impossible. Proteins often have nonzero electric dipole moments, making them interact with external electric fields and offering a means for controlling their orientation.
Through classical and *ab initio* molecular dynamics simulations, we identify a range of electric field strengths that allow for successful orientation of proteins without altering their structure. Additionally, we demonstrate that orientation information is crucial for successful structure determination in various experimentally relevant cases. Our findings suggest that non-destructive field orientation of intact proteins is a viable method that opens up new avenues for structural investigations using single particle imaging.



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