JAMMING UNDER RAPID PULLING IN DENSE GRANULAR SUSPENSIONS

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the James Franck Institute, University of Chicago, IL 60637 — It requires a lot of
force to quickly pull out an object immersed in a bath of dense granular suspension
like corn starch in water. To understand such striking force response, we experimen-
tally measure the normal force required for pulling out a cylindrical rod vertically
from the suspension at a controlled pulling velocity. We observe that for slow pulling
velocities the force response is similar to that of highly viscous fluids but above a
certain threshold velocity the force show a diverging behavior soon after the initial
viscous-like response. The time delay between the initial viscous-like and the diverg-
ing force response crucially depends on the proximity of the container walls from the
initial contact region of the pulling rod with the suspension. We use in-situ X-ray
radiography techniques to map out the local velocity profiles inside the suspension
using metallic tracer particles which reveals that the force divergence takes place
under pulling when the motion inside the suspension extends up to the container
walls. Although the exact mechanism remains to be explained, our experiments
suggest that both the magnitude and the delay in force response under pulling are
reminiscent of dynamic jamming under impact in dense granular suspensions.

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