Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Under Pressure: Mechanics of Swelling Hydrogels Under Confinement JEAN-FRANCOIS LOUF, NANCY B. LU, MARGARET G. O'CONNELL, Princeton University, H. JEREMY CHO, University of Nevada, Las Vegas, SUJIT S. DATTA, Princeton University — Hydrogels hold promise in agriculture as reservoirs of water in dry soil, potentially alleviating the burden of irrigation. However, confinement in soil can drastically reduce the ability of hydrogels to absorb water and swell—in some cases, by as much as 90 vol%—limiting their wide-spread adoption. Unfortunately, the underlying reason remains unknown. By directly visualizing the swelling of hydrogels confined in three-dimensional (3D) granular media, we demonstrate that the extent of hydrogel swelling is determined by the competition between the force exerted by the hydrogel due to osmotic swelling and the confining force transmitted by the surrounding grains. Further, we demonstrate that the medium can itself be restructured by hydrogel swelling, as set by the balance between the osmotic swelling force, the confining force, and inter-grain friction. Together, our results provide quantitative principles to predict how hydrogels behave in confinement, potentially improving their use in agriculture as well as informing other applications such as oil recovery, construction, mechanobiology, and filtration.

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Date submitted: 20 Oct 2020 Electronic form version 1.4