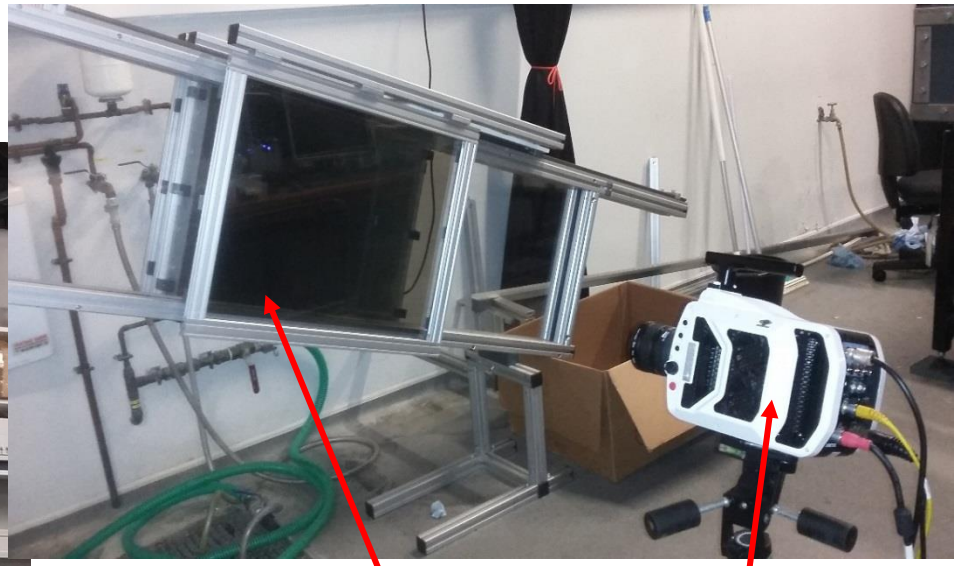
Experimental setup



two opposite polarizing films

high-speed camera

acrylic walls

Coarse-graining ρ and v fields

φ: coarse-graining function depends on lengthscale w

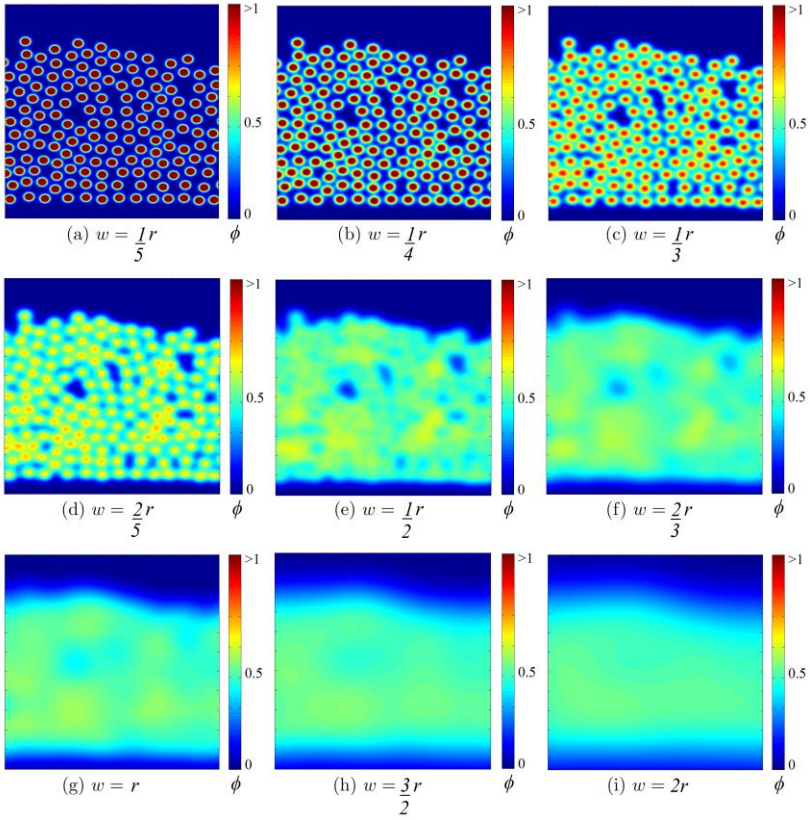
$$\equiv \frac{1}{V(w)} H(w - \|\boldsymbol{r}\|)$$

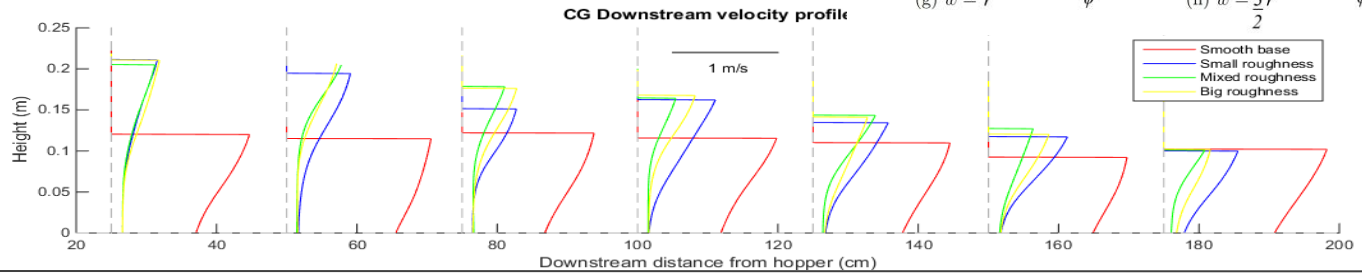
- Density: $\rho(\boldsymbol{r}, t) \equiv \sum_i m_i \, \delta(\boldsymbol{r} - \boldsymbol{r}_i)$

$$\rho(r, t) \equiv \sum_i m_i \, \varphi(\boldsymbol{r} - \boldsymbol{r}_i(t))$$

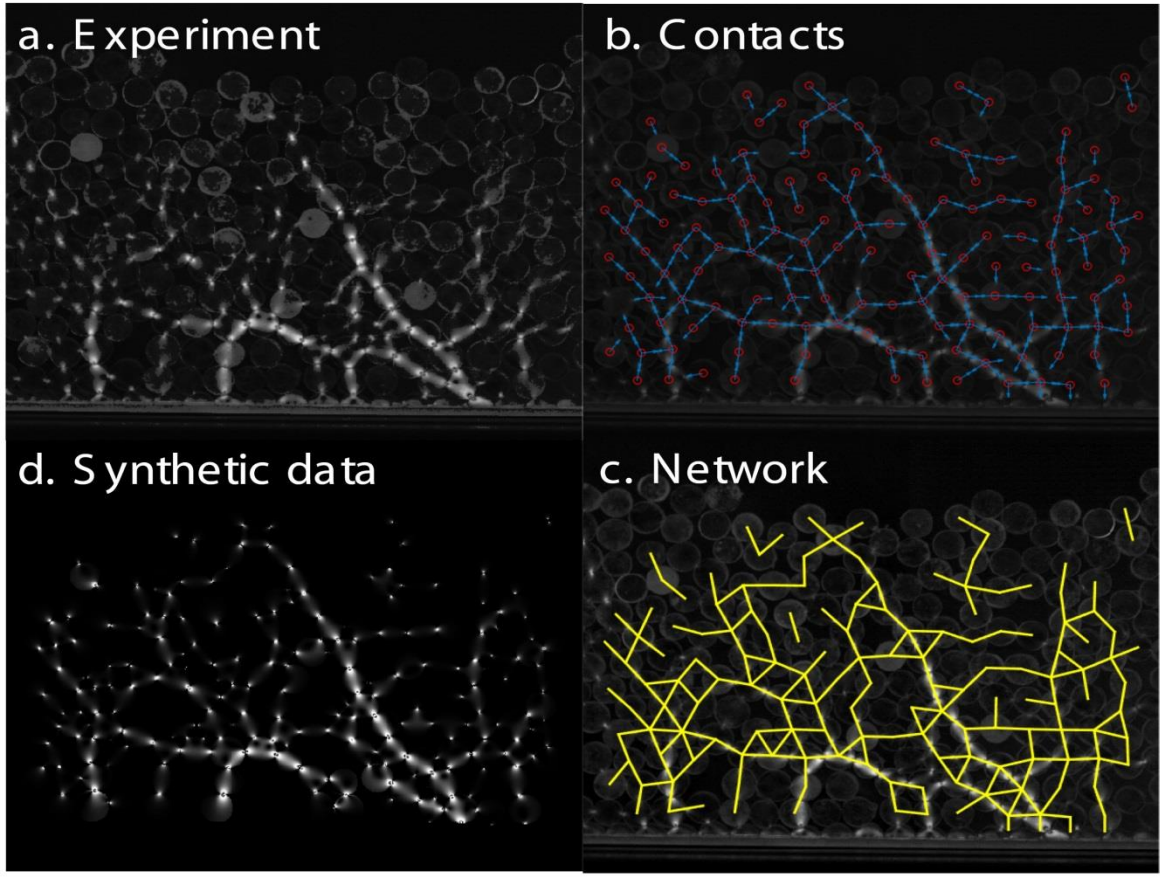
- Momentum: $\boldsymbol{p}_\alpha(\boldsymbol{r}, t) \equiv \sum_i m_i \, v_{i\alpha} \, \varphi(\boldsymbol{r} - \boldsymbol{r}_i(t))$

- Velocity: $V_\alpha(r, t) \equiv \dfrac{\boldsymbol{p}_\alpha(\boldsymbol{r}, t)}{\rho(\boldsymbol{r}, t)}$





Coarse-graining σ field



$$\sigma_{\alpha\beta} \equiv -\sum_{i} m_i \, v'_{i\alpha} \, v'_{i\beta} \, \varphi_i - \sum_{i=1}^{N} \sum_{j=i+1}^{N} f_{ij\alpha}(\varphi_i - \varphi_j) + \sigma_{\alpha\beta}^{base}$$