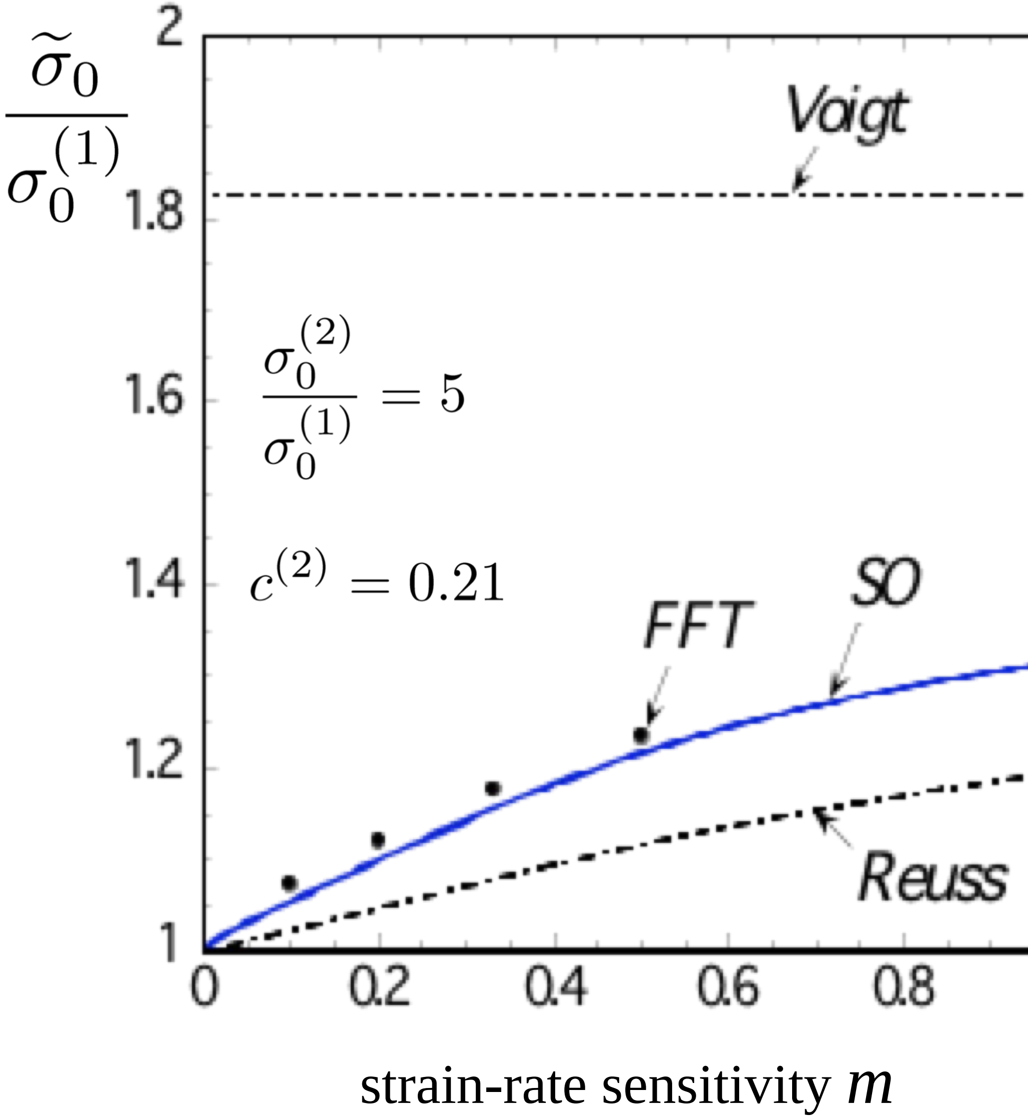
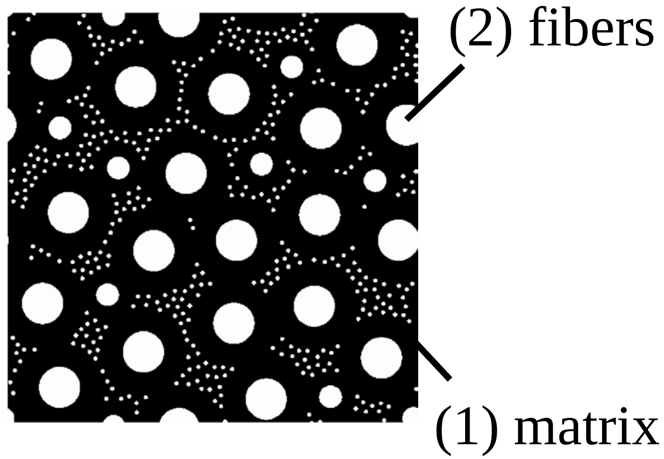
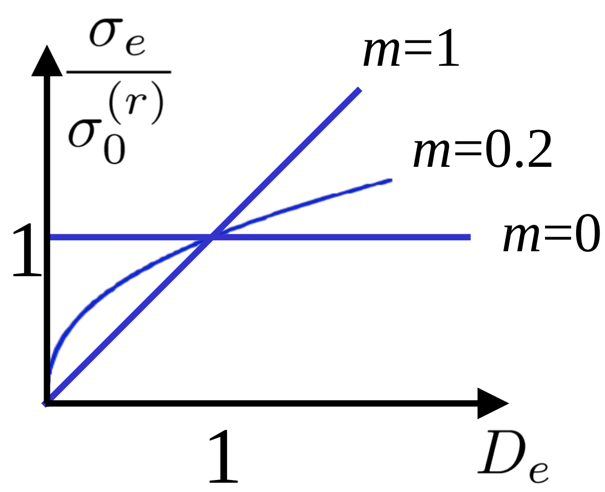
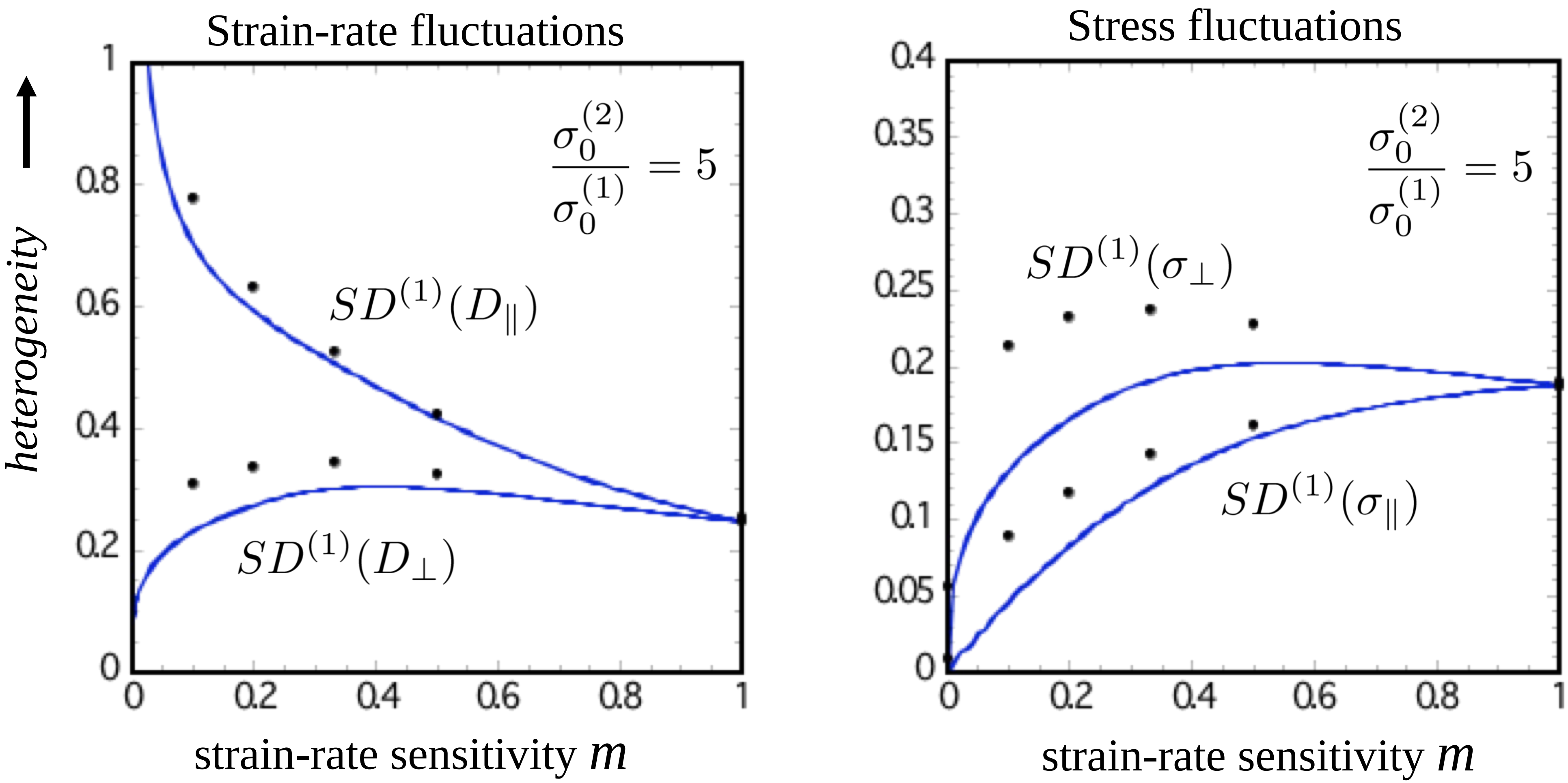
Effective behavior







Fluctuations of local fields in matrix phase

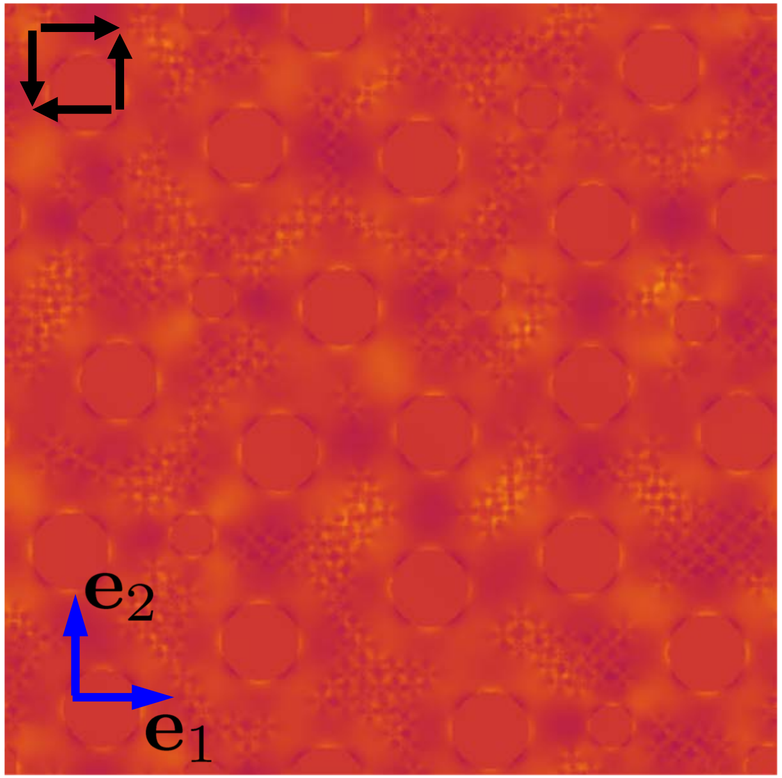


$$SD^{(1)}(\cdot) = \sqrt{\langle(\cdot)^2\rangle^{(1)} - (\langle\cdot\rangle^{(1)})^2}$$

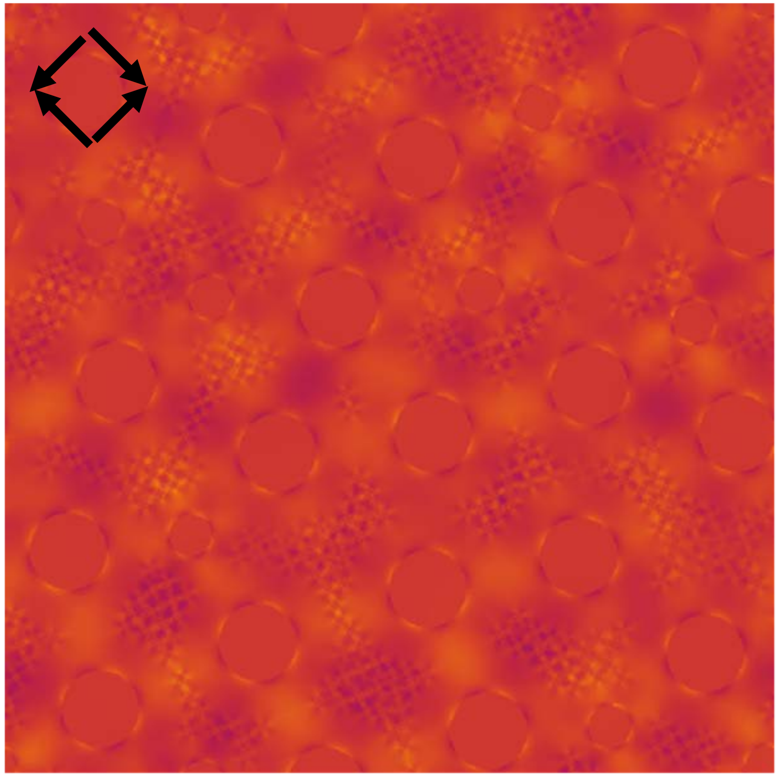
Linear phases (*m* = 1)

Full-field simulations – intraphase fluctuations

$$D_{\|} = D_{12}$$



$$D_{\perp} = \frac{1}{2}(D_{11} - D_{22})$$

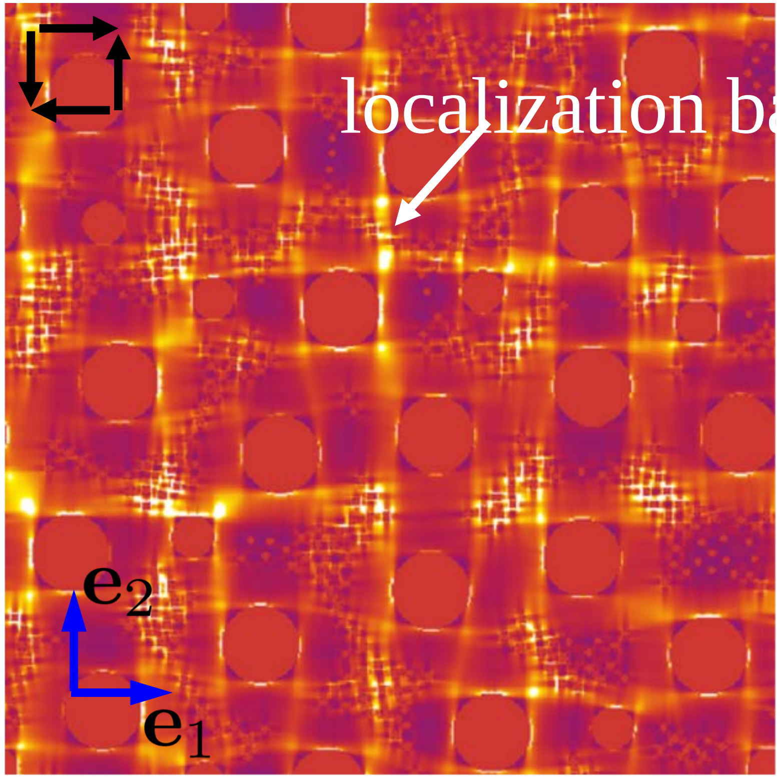


- strain-rate fluctuations are isotropic

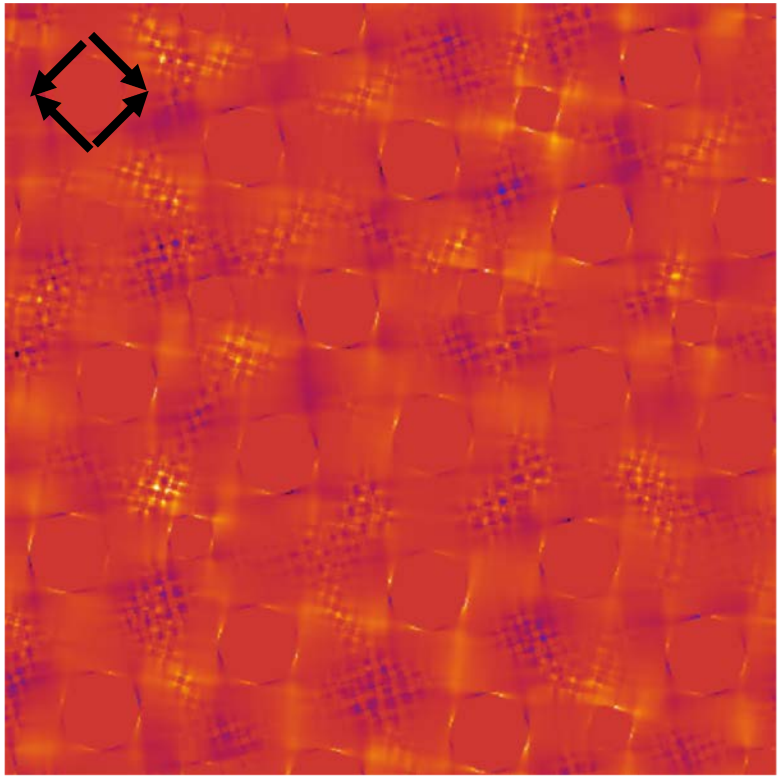
Nonlinear phases ($m = 0.1$)

Full-field simulations – intraphase fluctuations

$$D_{\parallel} = D_{12}$$

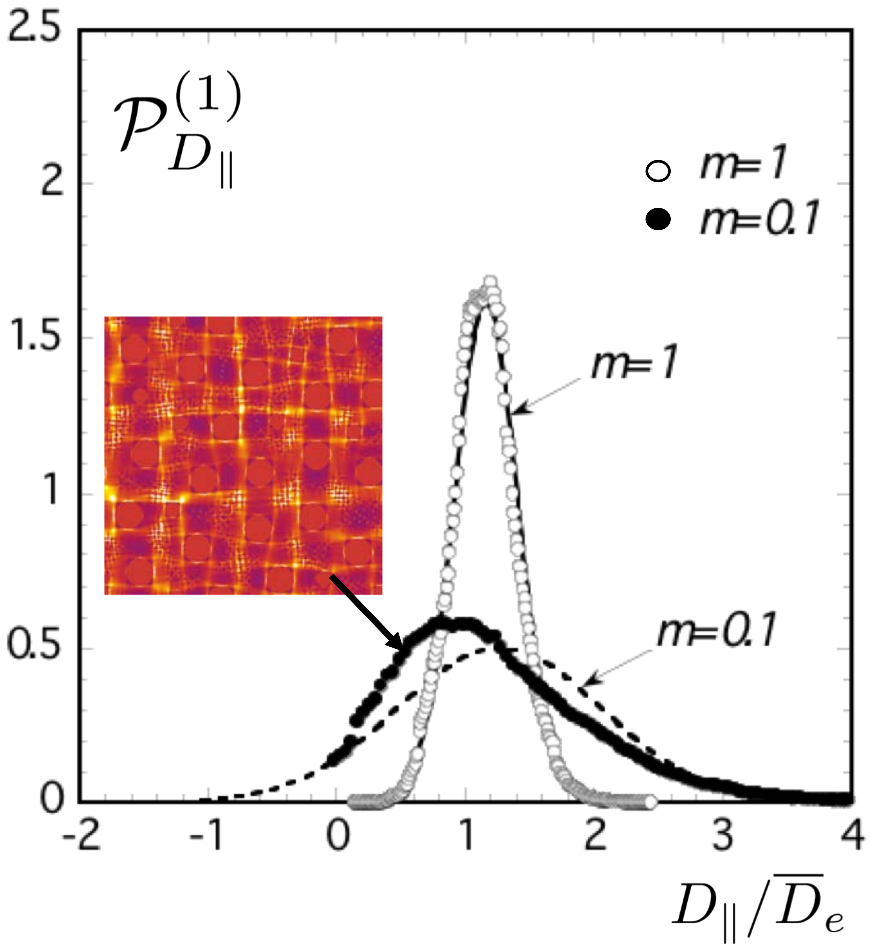


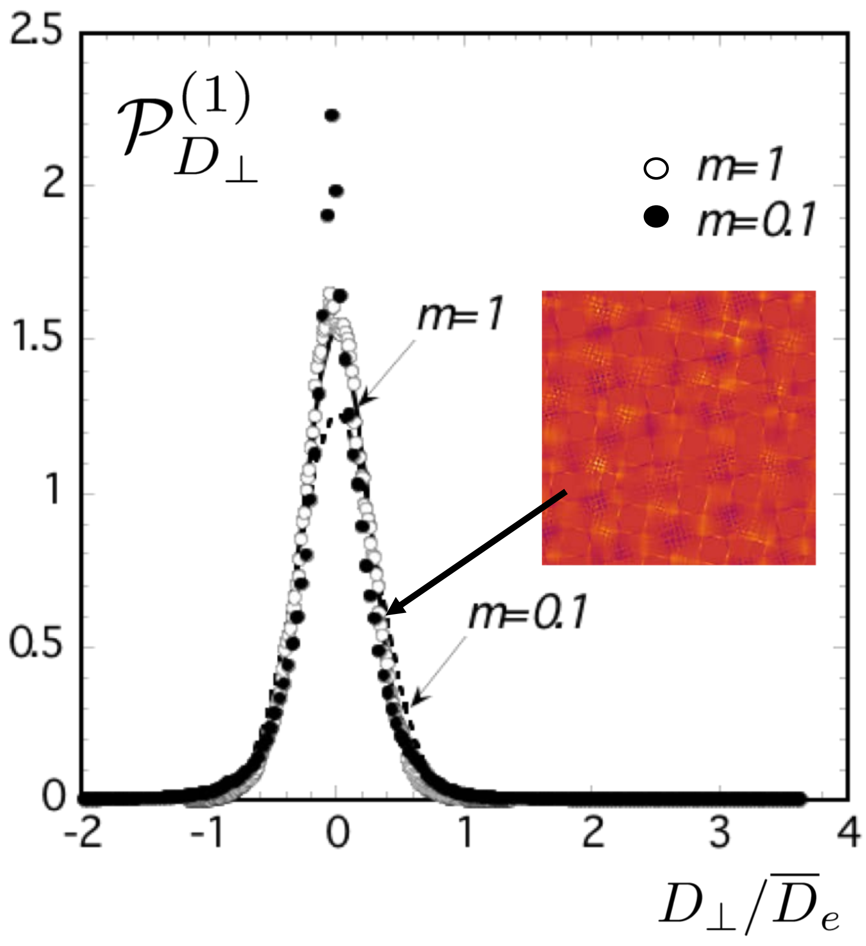
$$D_{\perp} = \frac{1}{2}(D_{11} - D_{22})$$



- strain-rate fluctuations increase and become anisotropic

Full-field simulations – distributions





- Homogenization can be used to estimate low-order moments

Conclusions

- Homogenization Methods have been developed for heterogeneous materials with nonlinear material behaviour making use of optimally designed Linear Comparison Composite.

Ponte Castañeda (2015) PRS A, (2016) JMPS

- The methods can be used to generate bounds and estimates of different types for the macroscopic (average) response.

- By means of appropriate perturbations, the methods can be used to generate estimates for the mean and covariance of the stress and strain fields in the phases.

- The methods can account for complex, multiscale microstructures including porosity (damage) as well as crystallographic and morphological texture, thus capturing the complex coupled effect of "crystallographic" and "morphological" anisotropy.

- For more details on applications:

Song & Ponte Castañeda (2017, 2018) JMPS, (2018) IJP