

A Minimal Continuum Model of Vaso-occlusion in Sickle Cell Disease

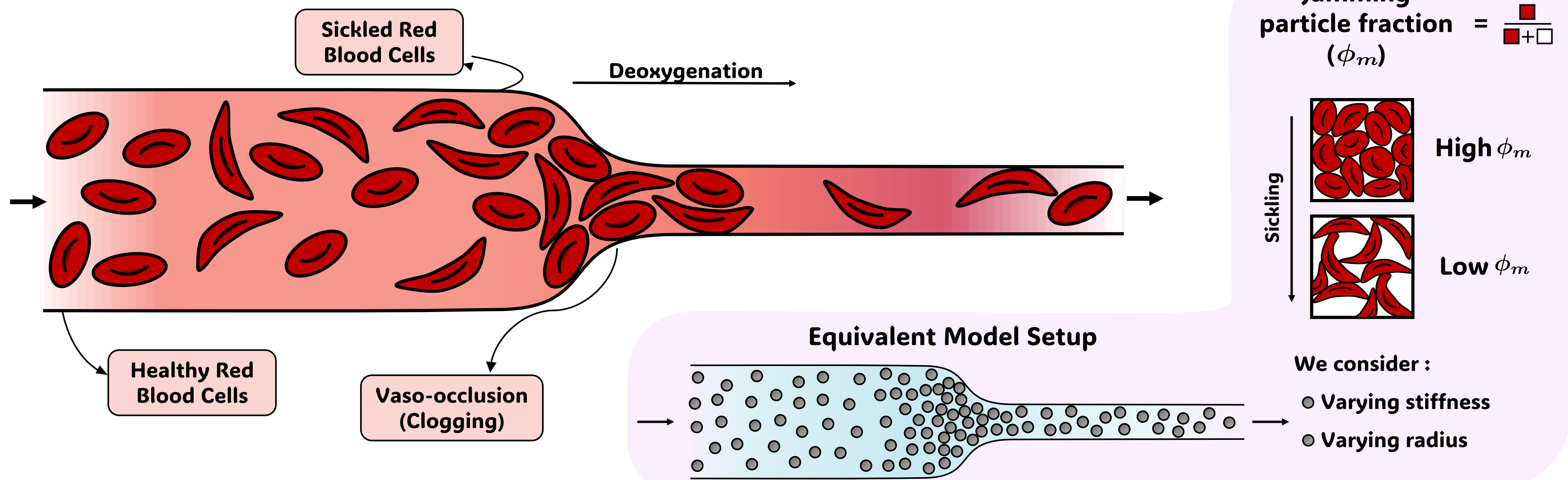
Anushka Herale¹, Philip Pearce¹, Duncan Hewitt²

¹ Department of Mathematics, University College London, ² DAMTP, University of Cambridge



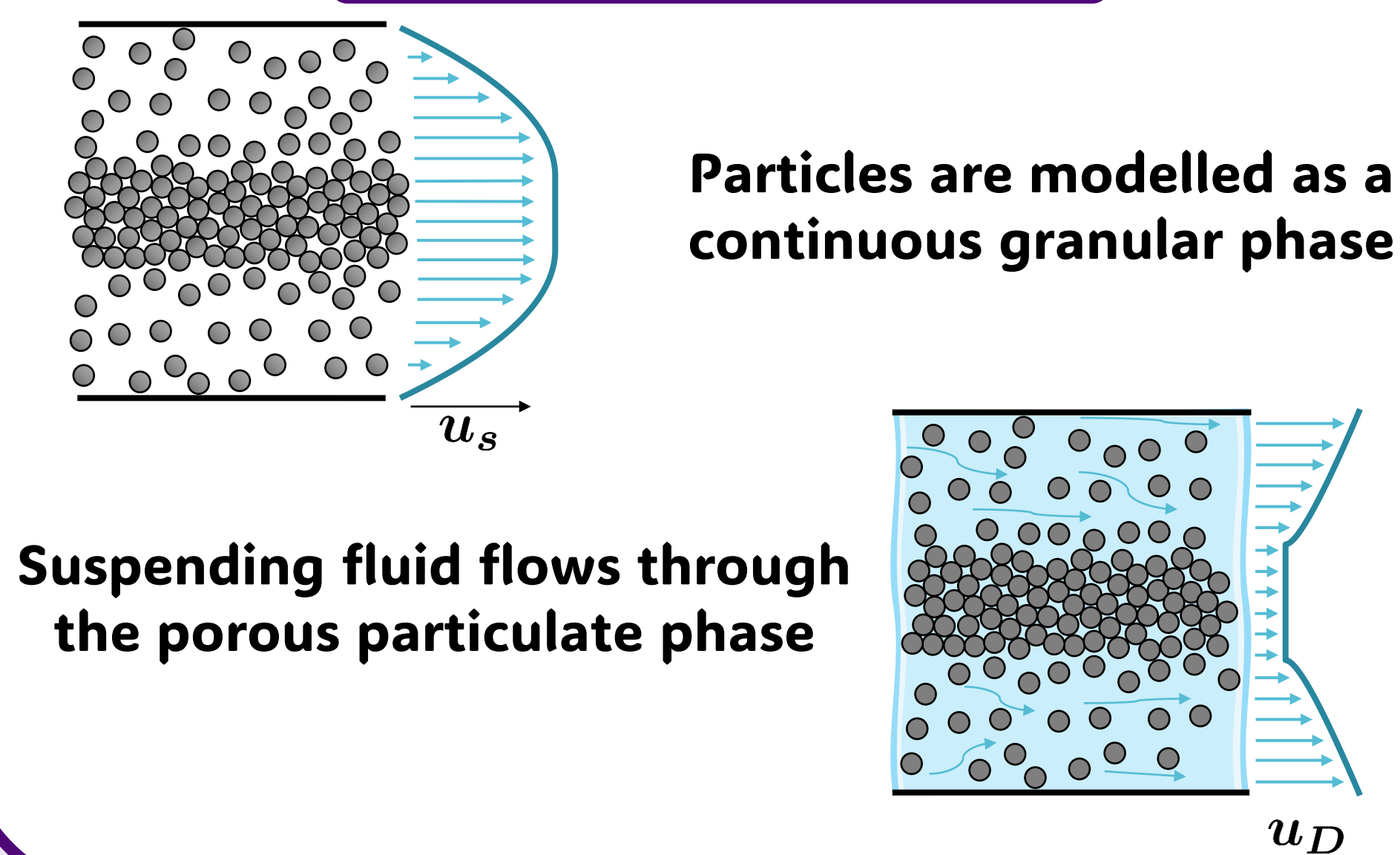
What happens in Sickle Cell Disease?

- In patients with sickle cell disease (SCD), the red blood cells (RBCs) lose their flexibility and stiffen upon deoxygenation in the veins. This can lead to painful episodes called vaso-occlusive crises (VOCs).
- VOCs are a major cause of morbidity and mortality in SCD patients worldwide.

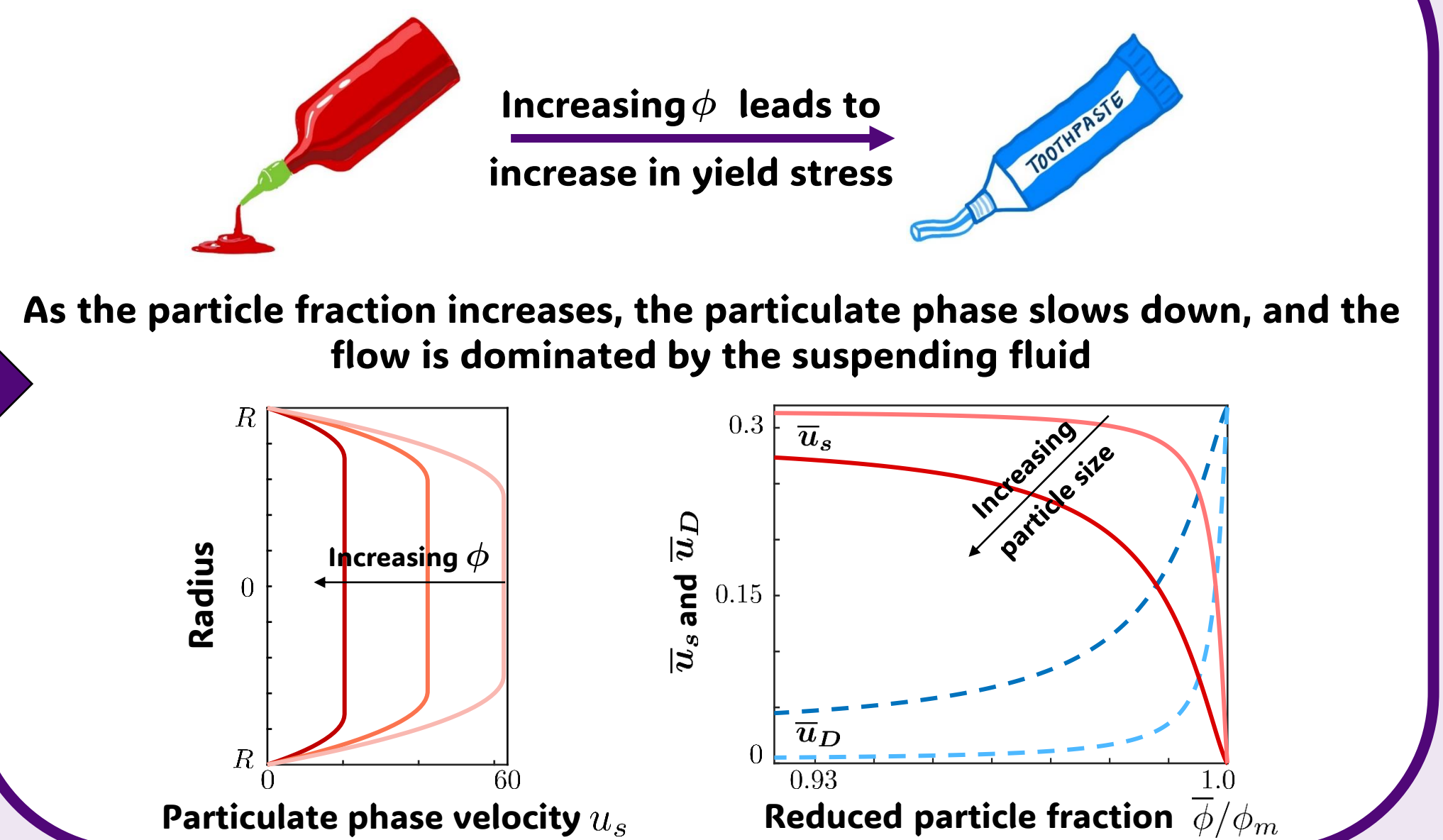


What are the factors that drive the onset of vaso-occlusive crises?

Multiphase Model

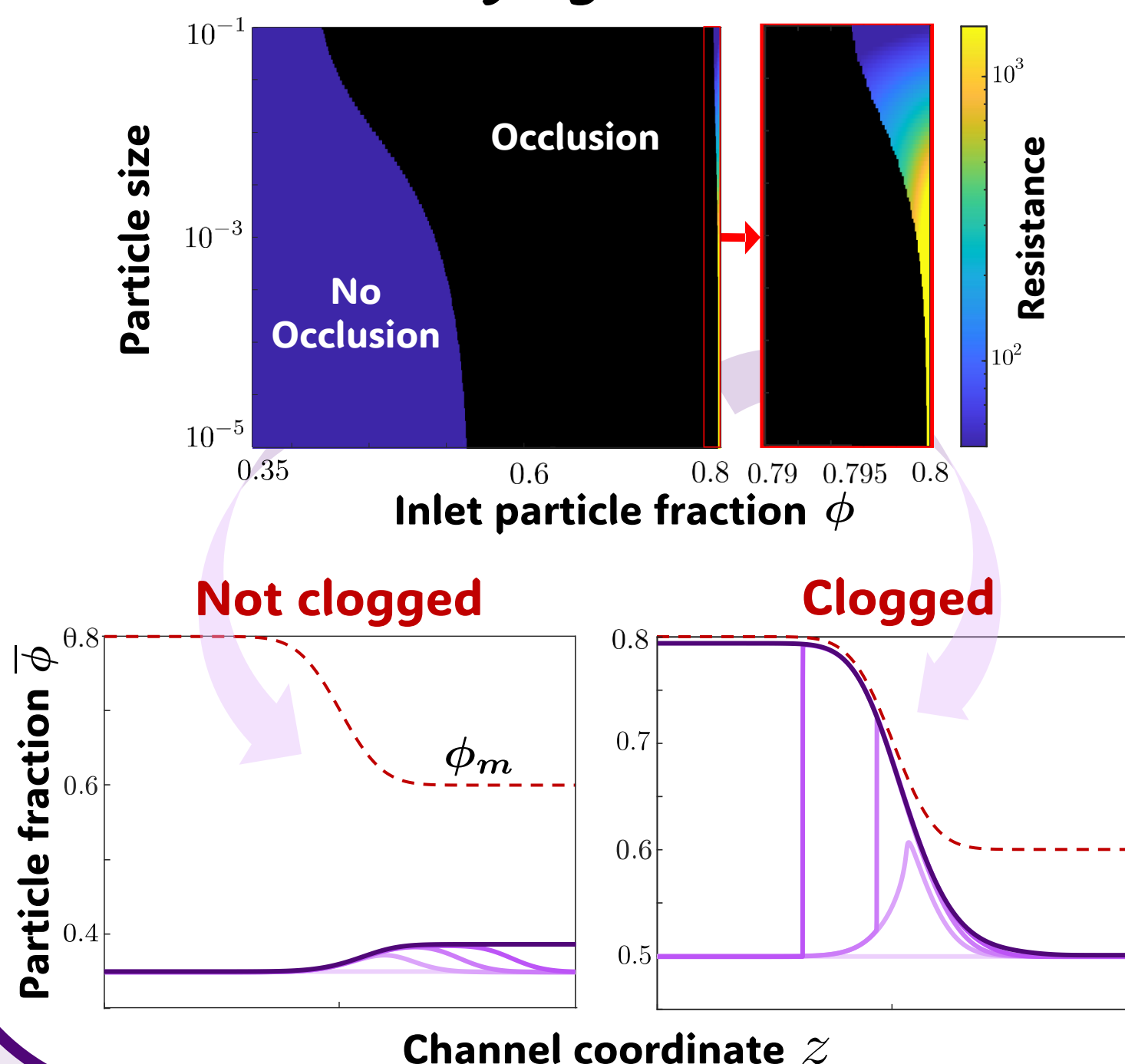


Effect of particle fraction ϕ



What does our model predict?

Varying Stiffness

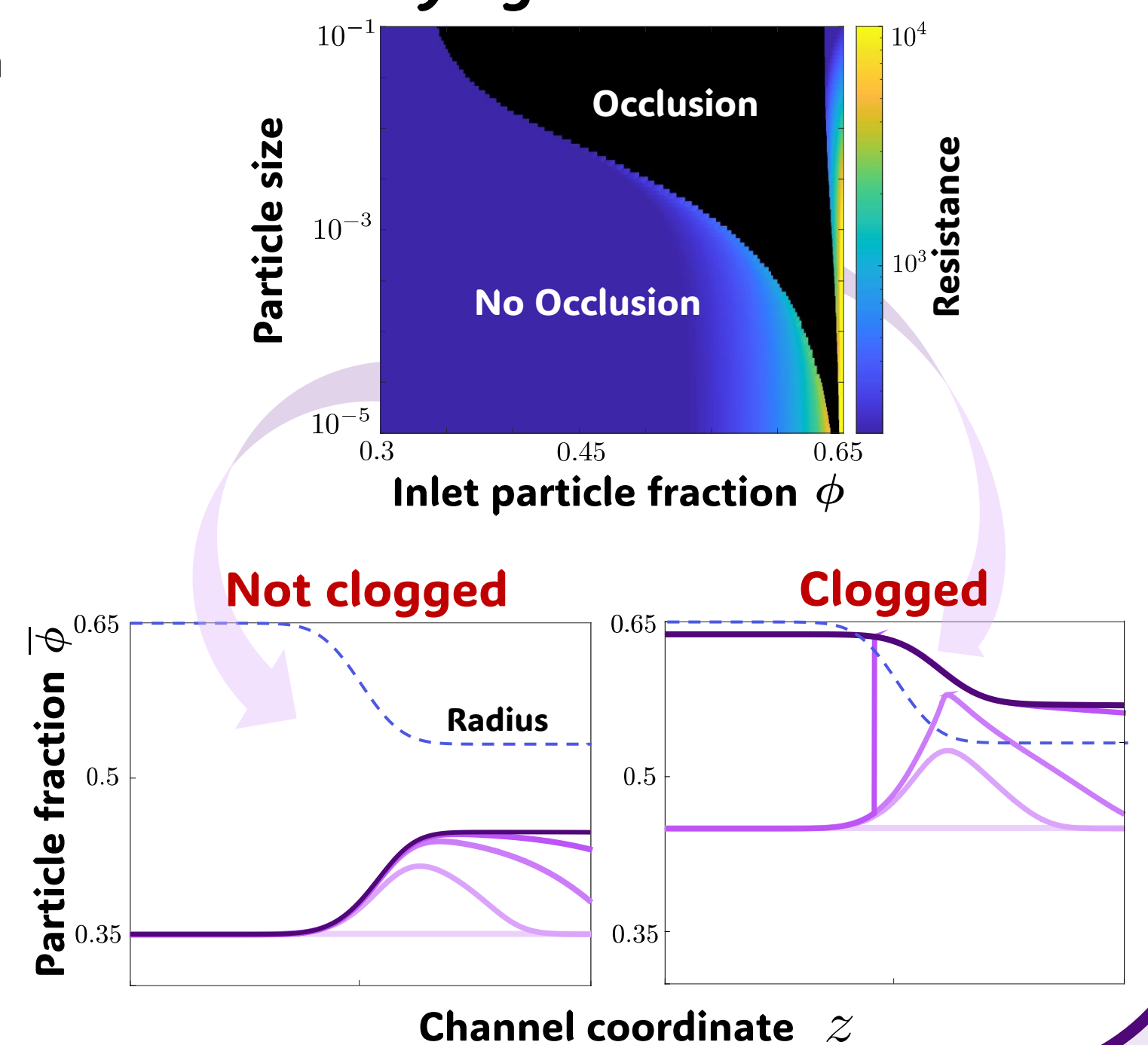


Clogged states occur for certain ranges of particle fractions and sizes, when we vary stiffness or radius of the channel

KEY RESULT

The model provides a clogging criterion which can be used to identify blood parameters linked to increased vaso-occlusion risk

Varying Channel Radius



References

- D. K. Wood, A. Soriano, L. Mahadevan, J. M. Higgins, & S. N. Bhatia (2012). A Biophysical Indicator of Vaso-occlusive Risk in Sickle Cell Disease. *Sci. Transl. Med.*, 4(123), 123ra26-123ra26.
- Anushka Herale, Philip Pearce, & Duncan Hewitt. (2025). Emergent clogging of continuum particle suspensions in constricted channels. [Under review, *JFM Rapids*]

E-mail: anushka.herale.21@ucl.ac.uk