University of Muenster/Warwick MASDOC Graduate Exchange

Pravin Madhavan

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Discontinuous Galerkin methods for coupled bulk-surface equations

The project is a collaboration between Pravin Madhavan, PhD student at the University of Warwick (supervisors: Andreas Dedner and Björn Stinner) and Sebastian Westerheide, PhD student at the University of Muenster (supervisor: Christian Engwer).

Many applications in physics, biology or chemistry exhibit complex geometrical shapes. often these models feature partial differential equations (PDEs) on the domain and this surface. At the same time, the domain might be time-dependent, e.g. in cell biology the shape of a cell depends on its internal state and couples back to the cell metabolism. A wide range of methods have been developed to deal with such problems, namely methods based on level set descriptions of the surface and phase-field methods. But due to the diffusive representation of the coupling interface these methods can lead to numerical artifacts, including spurious fluxes.

A new numerical method developed by Engwer & Westerheide and based on the unfitted discontinuous Galerkin (UDG) discretisation of the bulk equation and a level set based extension of it to solve the surface PDE has been shown to be an efficient new way of solving bulk-surface problems. The project involves modifying their method by solving the surface PDE using the surface DG method considered in Dedner et al. [2013] and comparing the two approaches from a computational point of view.

We aim to have our meeting in Muenster (Germany) late September. Sebastian may come and visit Warwick later on. To cover the costs of this collaboration, I will require around £**600**. We will need around £**200** $\times 2$ to cover travel costs to Muenster/Warwick and will require accommodation for 4 nights, which will cost around £**100** $\times 2$ ($2 \times$ £25×4 nights).

References

Andreas Dedner, Pravin Madhavan, and Björn Stinner. Analysis of the discontinuous galerkin method for elliptic problems on surfaces. *IMA Journal of Numerical Analysis*, 2013. doi: 10.1093/imanum/drs033. URL http://imajna.oxfordjournals.org/content/early/2013/01/23/imanum.drs033.abstract.