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Nonconforming virtual element methods for fourth-order problems

MS26: POLYGONAL AND POLYHEDRAL DISCRETIZATIONS FOR PARTIAL DIFFERENTIAL EQUATIONS

Andreas Dedner[1] **and Alice Hodson**[1]

[1]University of Warwick, Coventry, CV4 7AL, UK,
a.s.dedner@warwick.ac.uk,
alice-rachel.hodson@warwick.ac.uk

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In this talk we discuss nonconforming virtual element methods for a wide range of fourth-order problems. The construction of even a lowest order C^1 conforming space is not straightforward within the standard finite element setting and higher order nonconforming spaces suitable for fourth-order problems are also not readily available. Consequently, many software packages only provide the lowest order Morley element for discretizing fourth-order problems without requiring the use of splitting techniques.

In this talk, we follow the approach of defining a hierarchy of projection operators for the necessary derivatives. The starting point is a constraint least squares problem, as discussed in [3]. We show that by defining the projection operators without using the underlying variational problem, we can directly apply our method to nonlinear fourth-order problems. Another major advantage of this approach is that it can also be included more easily into existing software frameworks.

We discuss the application of our generalised method to the Cahn-Hilliard equation as presented in [2]. As a consequence of our approach, we do not require any special treatment of the nonlinearity as seen in e.g. [1]. Our method is shown to converge with optimal order also in the higher order setting.

REFERENCES

[1] Antonietti, P. F., Beirão da Veiga, L., Scacchi, S., and Verani, M. A C^1 Virtual Element Method for the Cahn–Hilliard Equation with Polygonal Meshes. *SIAM J. Numer. Anal. 54*, 1 (2016), 34–56.

[2] Dedner, A., and Hodson, A. A higher order nonconforming virtual element method for the Cahn-Hilliard equation. *arXiv preprint arXiv:2111.11408* (2021).

[3] Dedner, A., and Hodson, A. Robust nonconforming virtual element methods for general fourth-order problems with varying coefficients. *IMA J. Numer. Anal.* (2021).