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A new monotone finite volume scheme for diffusion equations on polygonal meshes. (Chinese. English summary) Zbl 1340.65189

Math. Numer. Sin. 37, No. 3, 316-336 (2015).

Summary: We construct a new monotone finite volume method for diffusion equations on star-shaped polygonal meshes. A distinct feature of the new scheme is that the discrete stencil of normal flux on a cell-edge can contain the cell-edge, which is different from the existing monotone schemes based on a nonlinear two-point flux approximation. That is, in the construction of discrete normal flux on each cell-edge, both the geometric character of distorted cells and the physical variables defined on that cell-edge are taken into account. The consistence of discrete flux is discussed, and the new scheme is proved to be monotone, i.e., it preserves positivity of analytical solutions for diffusion equations with strongly anisotropic and heterogeneous full tensor coefficients. Moreover, a design principle of general monotone schemes is proposed. Numerical results are presented to demonstrate the numerical performance of our new monotone scheme such as positivity-preserving, conservation, accuracy and efficiency on distorted meshes.

MSC:

65M08 Finite volume methods for initial value and initial-boundary value problems involving PDEs
65M50 Mesh generation, refinement, and adaptive methods for the numerical solution of initial value and initial-boundary value problems involving PDEs
35K05 Heat equation

Keywords:

diffusion equation; finite volume scheme; monotonicity; polygonal meshes; consistence; Numerical results; positivity-preserving; conservation