Abstract:

Stream function formulation of surface Stokes equations

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In recent years there has been a strong increase in research on numerical simulation methods for surface (Navier-)Stokes equations. By far most of the paperson numerical methods for surface ow problems treat the (Navier-)Stokes equa-tions in the primitive velocity and pressure variables. In this presentation wetreat several aspects related to the surface (Navier-)Stokes equation in streamfunction formulation.We consider a smooth connected (not necessarily simply connected) ori-ented hypersurface in three-dimensional space without boundary. Appropriatesurface gradient, divergence, curl and Laplaceoperators are de_ned in terms of the standard di_erential operators of the ambient Euclidean space. These repre-sentations are very convenient for the implementation of numerical methods forsurface partial di_erential equations. A derivation of the surface Helmholtz de-compositionand its relation to the surface Hodge decomposition are explained.Based on this Helmholtz decomposition a well-posed stream function formula-tion of a class of surface Stokes problems is derived. This results in a fourthorder scalar surface PDE for the stream function. A particular _nite elementmethod for this stream function PDE is proposed and results of a numericalexperiment with this method are presented.