Applications of Euler equation in cosmology

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Abstract:
In this paper we show how the Euler equation is used to describe a cosmological fluid. We use Newtonian dynamics to show how the linear theory of structure formation can be obtained using the Euler's linear equation and show how this equation can be modified to include the fluid pressure and build the spherical collapse model that allows us a first phenomenological approximation of the structures in the Universe.

Asymptotic solutions near blowup in inviscid MHD shell model

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Abstract:
This work addresses the problem of existence of blowup in a O.N. shell model of MHD turbulence and develops a method which finds asymptotic solutions of the model near the blowup. First, we prove an analytical criterion for blowup in our model. Then, after suitable definition of a renormalization scheme (which takes blowup time to infinity) and the study of the relationship between the symmetries of the renormalized and original models, we show how asymptotic solutions near blowup can be found and understood using solutions of the renormalized model and its attractors. We present some simulations, supporting these results.
This work is product of the author's still in course Masters studies at IMPA under Dr. Alexei Mailybaev and funding from ANP.

On the asymptotic behavior of solutions of the incompressible stationary Navier-Stokes equations in dimension three

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Abstract:
In this poster, I will address the asymptotic behavior of the solutions of the incompressible stationary Navier-Stokes system in thefull space, with a forcing term whose sympototic behavior at infinity is homogeneous of degree -3. We identify the asymptotic behavior at infinity of the solution. We prove that it uniquely solves the same equation but with a forcing term which involves an additional Dirac mass. This applies in particular to the case of a sufficiently decreasing forcing term with non-zero integral, or to the case of an exterior domain.

Characterization of Serfati vorticities

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Abstract:
In the classical theorems proofs of existence of infinity energy solutions for the incompressible two-dimensional Euler equations in the whole plane (e.g. Yudovich's theorem), it is used the Biot-Savart law. Due to the Biot-Savart law properties, in these classical results there are always some decays imposed for the vorticity when the spatial variable tends to infinity. In [1], Serfati used an alternative identity to prove existence and uniqueness of solutions for bounded vorticities that have bounded velocities associated. In his result, no additional condition on the vorticity decay is required. As far as we know, the characterization of the flows covered by Serfati's theorem is still an open problem. In this work, we present a necessary condition for initial vortex patches be covered by Serfati's theorem. Furthermore, we present some examples and counter-examples that we believe to be important intermediate steps for a possible complete characterization of these flows. This is a joint work with Lopes Filho M. C. and Nussenzveig Lopes H. J.

[1] Serfati P., Solutions C^{∞} en temps, n-log Lipschitz bornées en espace et équation d'Euler. C. R. Acad. Sci. Paris Sér. I Math. 320(5): 555-558, 1995

Implementation of finite elements mortar using lagrange multiplier in homogêneous coordinates - application to structures of microwaves.

Moacir Moura de Andrade Filho

Abstract:
This work deals with the development and computing implementation in the high-performance Fortran language of non-conforming Mortar formulations, using the technique of the Lagrange Multipliers. The technique is applied in the analysis of waveguides in the band of microwaves. The implementation uses Mortar Finite Elements of the first orders.

The matrices resulting from the application of the Finite Elements Method Mortar for the problems of propagation were calculated using a technique of extended analytical integration, which is also presented. This extended approach allows the calculation of universal matrices for Finite Element nodal and also in the function Mortar in any order of approximation. The application of analytical integration technique is done with integrals written in homogeneous coordinates of the Finite Element. Thus, the matrices are calculated once and are independent of the dimensions of the element and dependent only on the type and order of approximation used. It is presented the solution and the processing time to some waveguides of complex geometry. The results obtained are compared with those presented in the literature. Using this technique, we have an improved quality of results and processing time (CPU time) compared to traditional Finite Element Method (FEM).