ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
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ΑΝΑΚΟΙΝΩΣΗ

Στα πλαίσια του Προγράμματος Μεταπτυχιακών Σπουδών του Τμήματος Μαθηματικών του ΕΚΠΑ, και σε συνδυασμό με το Γενικό Σεμινάριο, ο Καθηγητής

Δημήτριος Χριστοδούλου
Πολυτεχνείο ΕΤΗ, Ζυρίχη

θα δώσει τέσσερεις (4) διαλέξεις στο Τμήμα Μαθηματικών. Οι διαλέξεις αυτές θα είναι προσιτές σε ευρύ μαθηματικό ακροατήριο.

1η Διάλεξη

Τρίτη 29/05, ώρα 13:00-14:00 μ.μ., Αίθουσα Γ32
Τίτλος: Hyperbolic p.d.e. and Lorentzian geometry.

Περίληψη: In this lecture I shall first present continuum mechanics, both fluid mechanics as well as the mechanics of crystalline solids, as examples of Lagrangian theories of mappings of one manifold into another. I shall then define the notions of ellipticity and of hyperbolicity associated to a system of Euler Lagarange equations. I shall finally discuss the causal structure of the domain manifold defined by a solution of a hyperbolic system of equations, showing how generalized Lorentzian geometry comes into play.

2η - 3η Διάλεξη

1ο ΜΕΡΟΣ
Τετάρτη 30/5, ώρα 13:00-14:00 μ.μ., Αίθουσα Γ42
2Ο ΜΕΡΟΣ
Πέμπτη 31/5, ώρα 13:00-14:00 μ.μ., Αίθουσα Γ32

Τίτλος: The analysis of shock formation in 3-dimensional fluids (in two parts).

Περίληψη: In 2007 I published a monograph which treated the relativistic Euler equations in three space dimensions for a perfect fluid with an arbitrary equation of state. In this monograph I considered initial data which outside a sphere coincide with the data corresponding to a constant state. Under a suitable restriction on the size of the initial departure from the constant state, I established theorems which gave a complete description of the maximal classical development. In particular, I showed that the boundary of the domain of the maximal classical development has a singular part where the inverse density of the wave fronts vanishes, signalling shock formation. In fact, the theorems which I established gave a complete picture of shock formation in three-dimensional fluids. I shall give a simplified presentation of these results, assuming from the outset that the initial conditions are irrotational. The basic geometric concept on which the analysis is based is that of the acoustical spacetime manifold. The analysis features the interplay of the original system of equations with another system, the acoustical structure equations, which governs the causal structure of the acoustical manifold. The acoustical geometry degenerates as shocks form, nevertheless things remain smooth relative to a different differential structure, which is what permits a complete analysis of the singular boundary. The presentation will be in two parts. The first lecture shall introduce the topic and discuss the results, while the second lecture shall give an outline of the proof of the main theorem.

4η Διάλεξη

Παρασκευή 1 Ιουνίου, ώρα 13:00-14:00 μ.μ., Αίθουσα Γ42

Τίτλος: The short pulse method and the formation of trapped surfaces in general relativity.

Περίληψη: In 1965 Penrose introduced the fundamental concept of a trapped surface, on the basis of which he proved a theorem which asserts that a spacetime containing such a surface must be incomplete. The presence of a trapped surface implies, moreover, that there is a region of spacetime, the black hole, which is inaccessible to observation from infinity. A major challenge since that time had been to find out how trapped surfaces actually form, by analyzing the dynamics of gravitational collapse. In a monograph published in 2009 I achieved this aim by establishing the formation of trapped surfaces in pure general relativity through the focusing of incoming gravitational waves. The theorems proved therein constitute the first foray into the long-time dynamics of general relativity in the large, that is, when the initial data are no longer confined to a suitable neighborhood of trivial data. The main new method which this work introduces, the short pulse method, applies to general systems of Euler–Lagrange equations of hyperbolic type, and provides means to tackle problems which have hitherto been inaccessible. The method capitalizes on the assumption that the initial data, although smooth, change abruptly as we cross a certain surface, so there is a small parameter which corresponds to the distance within which the change is effected. A calculus is built in which this small parameter everywhere enters. This calculus is used to demonstrate that when the parameter in question is suitably small we have long time existence independently of the size of the initial data. And in the case of the Einstein equations, when this size is suitably large then trapped surfaces eventually form.