Title: Hydrodynamics and anomalies

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Abstract: Recently its has been found that relativistic hydrodynamics requires modifications in the presence of quantum anomalies. We will follow the theoretical developments that leads to this discovery and look at modern applications of hydrodynamics with anomalies.

Hydrodynamics and quantum anomalies

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Perimeter Institute colloquium
(May 28, 2014)

Plan of the talk

- Hydrodynamics
- Anomalies
- Gauge/gravity duality
- Hydrodynamics with anomalies
- We will trace out a single path in a complex story

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Navier-Stokes equation

- Continuity equation $\frac{\partial \rho}{\partial t} + \boldsymbol{\nabla} \cdot (\rho \mathbf{v}) = 0$

Momentum conservation $\frac{\partial \mathbf{v}}{\partial t} + (\mathbf{v} \cdot \boldsymbol{\nabla})\mathbf{v} = -\frac{1}{\rho}\boldsymbol{\nabla} P + \nu \nabla^2 \mathbf{v}$

(Energy conservation)

This simple set of equations lead to many complex physical phenomena

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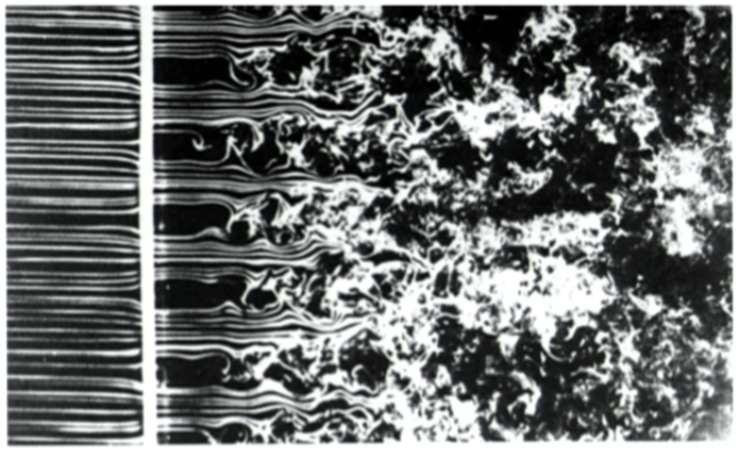
Hydrodynamic phenomena



(Van Dyke, Album of fluid motion)

Relativistic hydrodynamics

- The conservation of energy, momentum, baryon charge

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"Constitutive relations"

$$\vec{j} = \rho\vec{v} - D\vec{\nabla}\rho$$

advection diffusion

a similar equation for $T^{\mu\nu}$

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