A classical variational approach to dissipation in general relativity

Proc. R. Soc. A, 8 March 2011 vol. 467 no. 2127, pp. 738-759

BRITGRAV11 · UNIVERSITY OF GLASGOW · APRIL 2011

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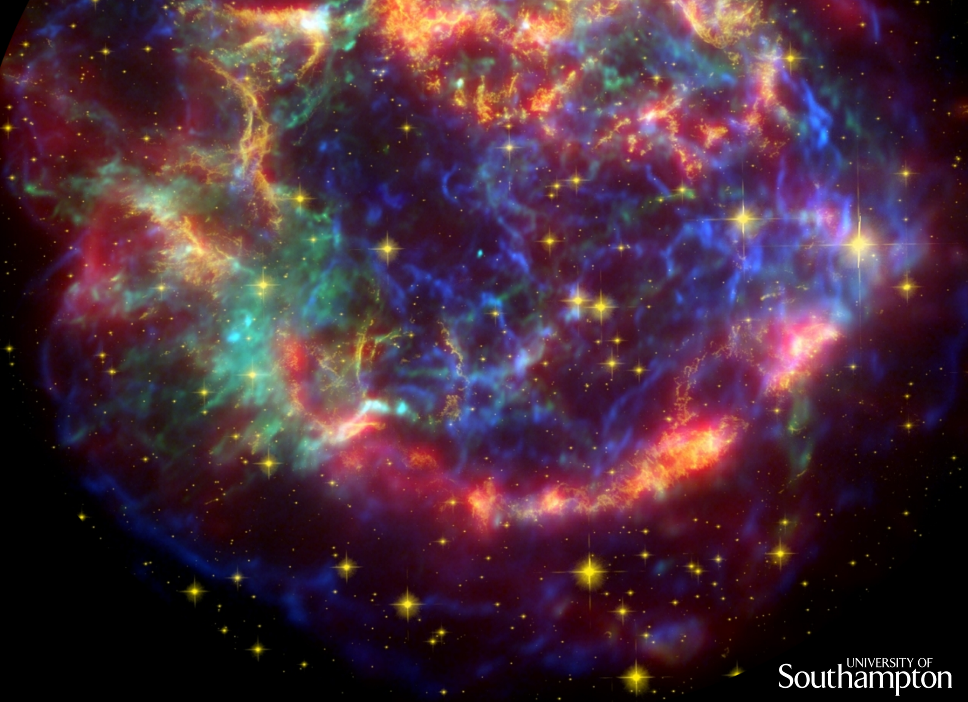

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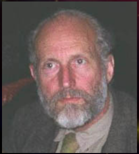

Thermodynamics

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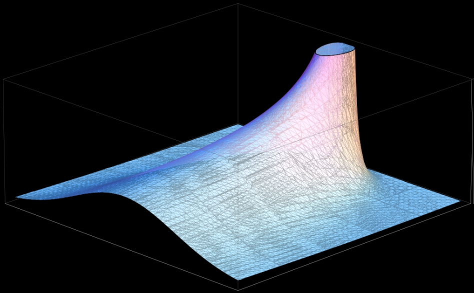
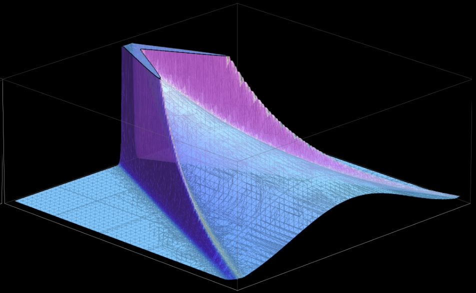
$\rho = \rho(n, s)$

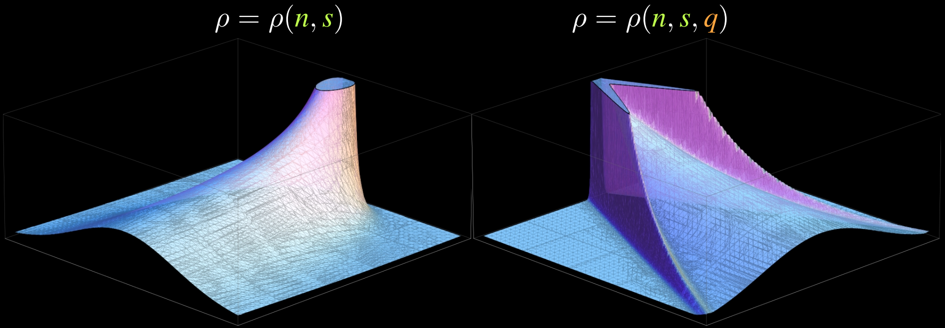


Heat Equation

$\rho = \rho(n, s, q)$



Telegraph Equation



Heat Equation

Telegraph Equation

Constitutive equations

Fourier's Law: $\mathbf{q} = -\kappa \nabla T$

Cattaneo eqn: $\tau \dot{\mathbf{q}} + \mathbf{q} = -\kappa \nabla T$

Covariant thermodynamics

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$$T^{b}_{a;b} = f^{\mathrm{n}}_{a} + f^{\mathrm{s}}_{a} = 0$$

Covariant thermodynamics

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$$f^{\mathrm{n}}_{a} = 2\mu_{[a;b]}n^{b} + n^{b}{}_{;b}\mu_{a}$$

$$f^{\mathrm{s}}_{a} = 2\theta_{[a;b]}s^{b} + s^{b}{}_{;b}\theta_{a}$$

Covariant thermodynamics

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$$f^{\mathrm{s}}_a = 2\theta_{[a;b]}s^b + s^b{}_{;b}\theta_a$$

Covariant electrodynamics

$$u^a{}_{;b}u^b = qF^a{}_b u^b$$
$$f^{em}_a = 2A_{[a;b]}j^b$$

Covariant thermodynamics

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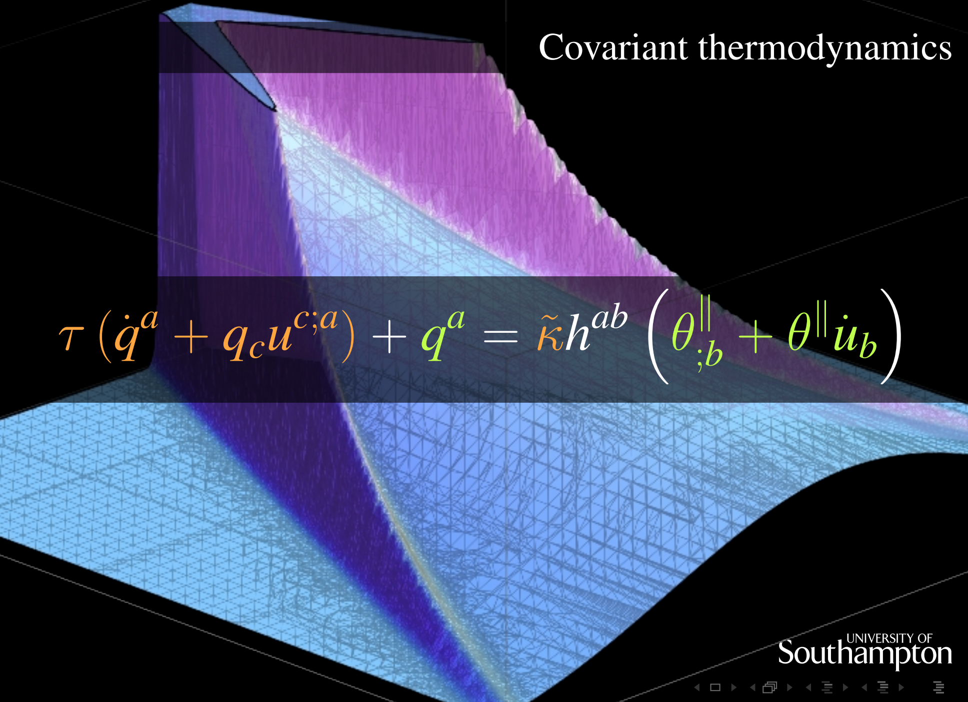
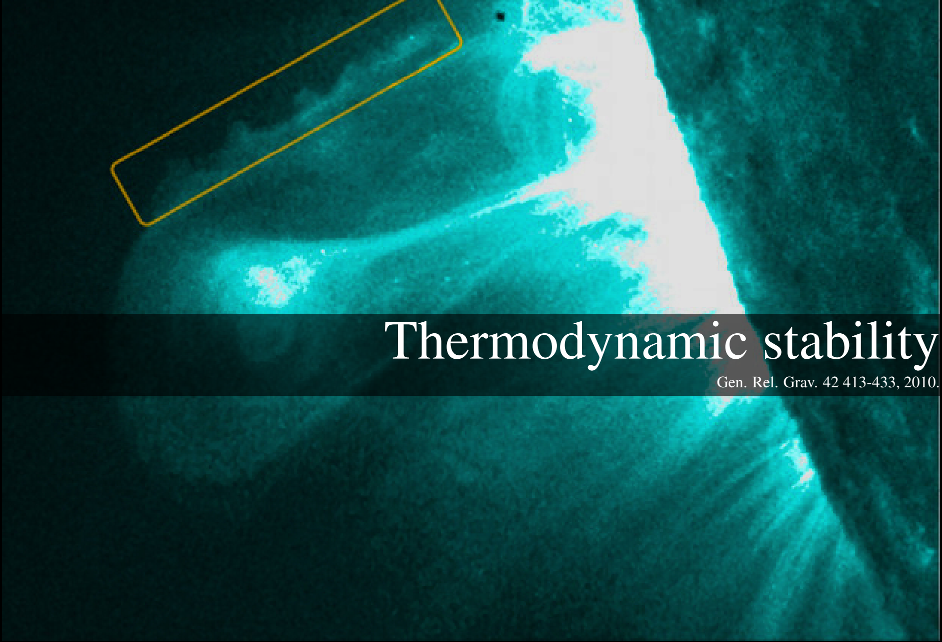


Covariant thermodynamics

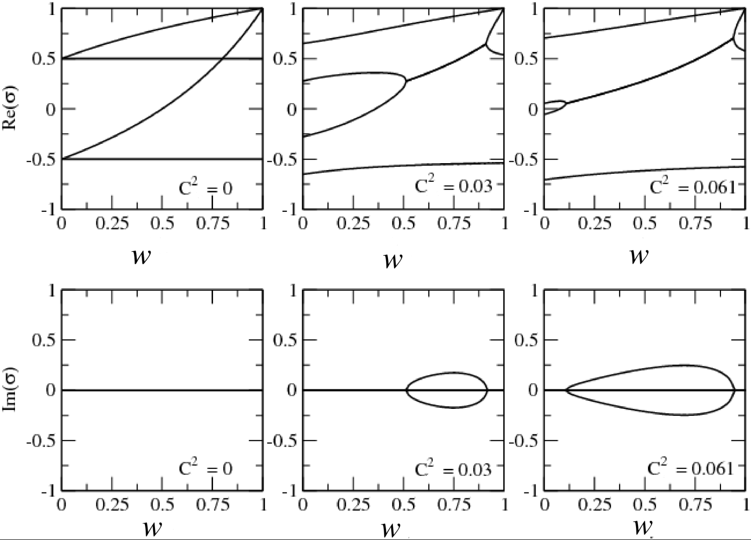
$$\tau\left(\dot{q}^a + q_c u^{c;a}\right) + q^a = \tilde{\kappa} h^{ab}\left(\theta^{\|}_{;b} + \theta^{\|}\dot{u}_b\right)$$



Thermodynamic stability

Gen. Rel. Grav. 42 413-433, 2010.

Two-stream thermodynamic instability



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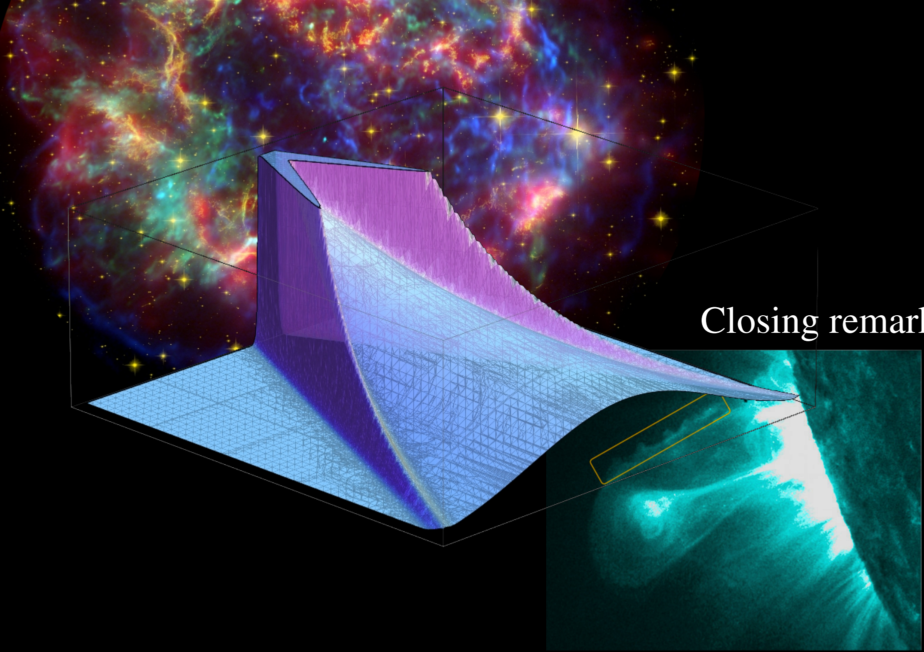

Closing remarks