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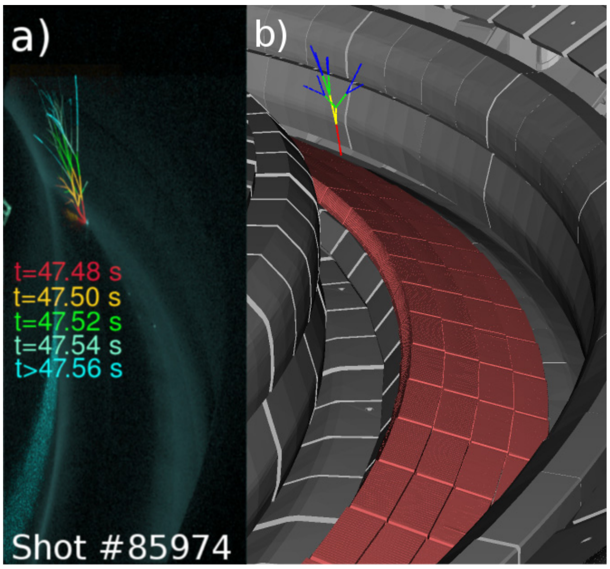
Highlights from the previous volumes

Spontaneous rapid rotation and breakup of metal droplets in tokamak edge plasmas

This paper presents theory and simulations of rotational breakup of liquid metal droplets addressing the previously unexplained phenomena of branching trajectories observed in tokamak plasmas. The model presented is in excellent agreement with observations and has pertinent implications for limiting impurity deposition, dust particle transport, plasma control and stability as well as the investigation of rotating charged spheres relevant to dust in astrophysical contexts.

Of 169 plasma discharges containing dust in JET, 103 exhibited at least one example of breakup, as shown in the figure below. Rotation rates inferred from the model of rotational instability are in excess of 10^5 Hz. This work represents part of an emerging field in the study of liquid plasma interactions of growing importance for next-generation magnetic confinement fusion devices and plasma physics research

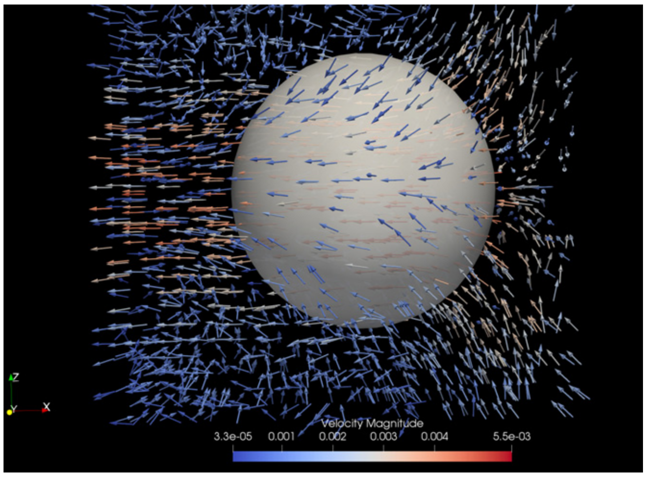


Liquid breakup event in JET observed experimentally (a) and in DTOKSU simulations (b).

Original article by HOLGATE J. T. *et al.*
EPL, **127** (2019) 45004

Contraction-based motility in a compressible active fluid

Cell motility is crucial to biological functions ranging from wound healing to immune response. Spontaneous movement and deformation are physically driven by the cell cytoskeleton. The cytoskeleton consists of protein filaments and motors which constantly consume chemical energy (ATP) and convert it to work. In particular, actin filaments interact with myosin motors to generate contraction forces in the cell, which drive cell motion and division. Most of the research has focused, both experimentally and theoretically, on cell migration on a two-dimensional substrate (crawling), providing a detailed outline of some basic migration mechanisms. However, some cells, such as breast tumor cells, can also “swim” in a straight line inside a 3D tissue or a polymeric fluid, in the absence of a substrate. The authors present a minimal model for pattern formation within a compressible actomyosin gel, which is numerically solved both in 2D and 3D. Contractility leads to the emergence of an actomyosin droplet within a low-density background. This droplet then becomes self-motile for sufficiently large motor contractility. Simulations also show that compressibility has the effect to facilitate motility, as it decreases the value of the isotropic contractile stress beyond which the droplet starts to move.

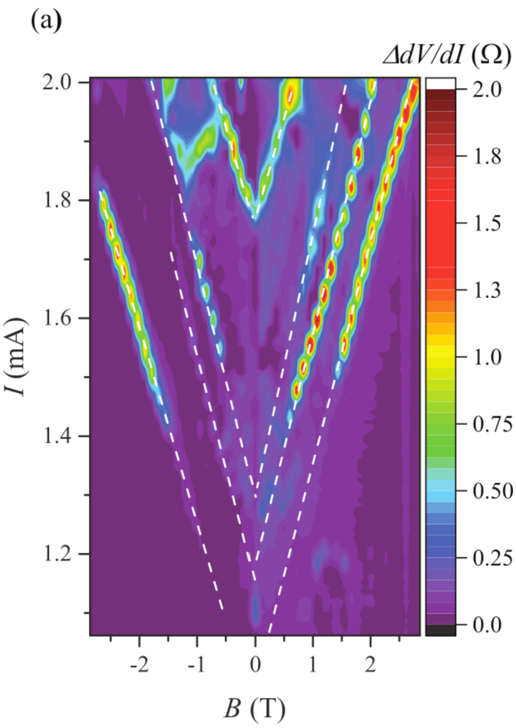


Actomyosin droplet with superimposed velocity field.

Original article by NEGRO G. *et al.*
EPL, **127** (2019) 58001

Multiple magnon modes in a magnetic Weyl semimetal

A strong area of interest in condensed-matter physics is represented by topological Weyl semimetals (WSMs). There are only a few candidates of magnetically ordered materials for the realization of WSMs, like the kagome-lattice ferromagnet $Co_3Sn_2S_2$. Novel magnon branches are predicted in magnetic Weyl semimetals, which can be understood as a result of the coupling between two magnetic moments mediated by Weyl fermions. Here, we experimentally investigate electron transport in the kagome-lattice ferromagnet $Co_3Sn_2S_2$, which is regarded as a time-reversal symmetry broken Weyl semimetal candidate. We demonstrate $\mathrm{d}V/I(I)$ curves with pronounced asymmetric $\mathrm{d}V/\mathrm{d}I$ spikes, similar to those attributed to current-induced spin-wave excitations in ferromagnetic multilayers. In contrast to multilayers, we observe several $\mathrm{d}V/\mathrm{d}I$ spikes' sequences at low, $\approx 10^4\ \mathrm{A/cm^2}$, current densities for a thick single-crystal $Co_3Sn_2S_2$ flake in the regime of fully spin-polarized bulk. The spikes at low current densities can be attributed to novel magnon branches in magnetic Weyl semimetals, which are predicted due to the coupling between two magnetic moments mediated by Weyl fermions. The presence of spin-transfer effects at low current densities in $Co_3Sn_2S_2$ makes the material attractive for applications in spintronics.

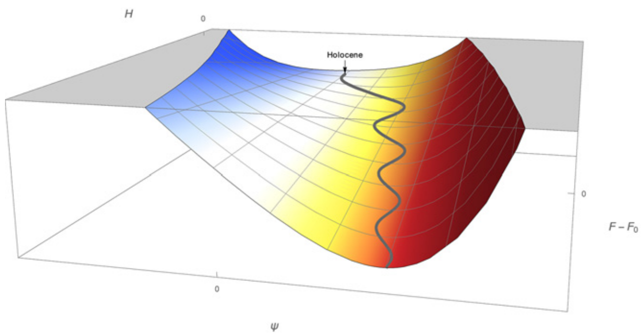


$\mathrm{d}V/\mathrm{d}l$ spikes' positions, which demonstrate several magnon branches with the linear field dependence.

Original article by Shvetsov O. O. *et al.*
EPL, **127** (2019) 57002

Understanding the dynamics of the Earth System

The Earth System (ES) is undergoing a dramatic transition due to human activities. A new geological epoch has been identified, the Anthropocene, in which human activities are the dominant driver of the ES. The authors have proposed a model, based on the Landau-Ginzburg theory, that describes this process as a phase transition, a qualitative change of the equilibrium conditions. In this publication, the authors have shown that the phase transition model can be expressed in terms of a dynamical systems approach. This allows for describing, not only the equilibrium points, but also the possible trajectories of the ES to those points in its phase space. It is shown that a finite amount of human-driven change leads the ES in a trajectory towards a Hothouse Earth scenario. It is also discussed how the complexity of the ES and the interaction among its Planetary Boundaries components, might allow for mitigating strategies that may result in an equilibrium temperature intermediary between the Holocene and a Hothouse Earth scenario.



Trajectory of the Earth System towards a Hothouse Earth scenario, where ψ is the temperature changes, F is the free energy, H expresses the human activites. Lower free energy means a more stable state.

Original article by Bertolami O. and Francisco F.
EPL, **127** (2019) 59001