

A TWO-STEP ROLE FOR PLASMA EXPANSION IN SOLAR WIND HEAT FLUX REGULATION

Maria Elena Innocenti¹, Elisabetta Boella², Anna Tenerani³, Marco Velli⁴

¹ Ruhr-Universität Bochum, DE ² Lancaster University & Cockroft Institute, UK ³ University of Texas at Austin, US ⁴ UCLA, US

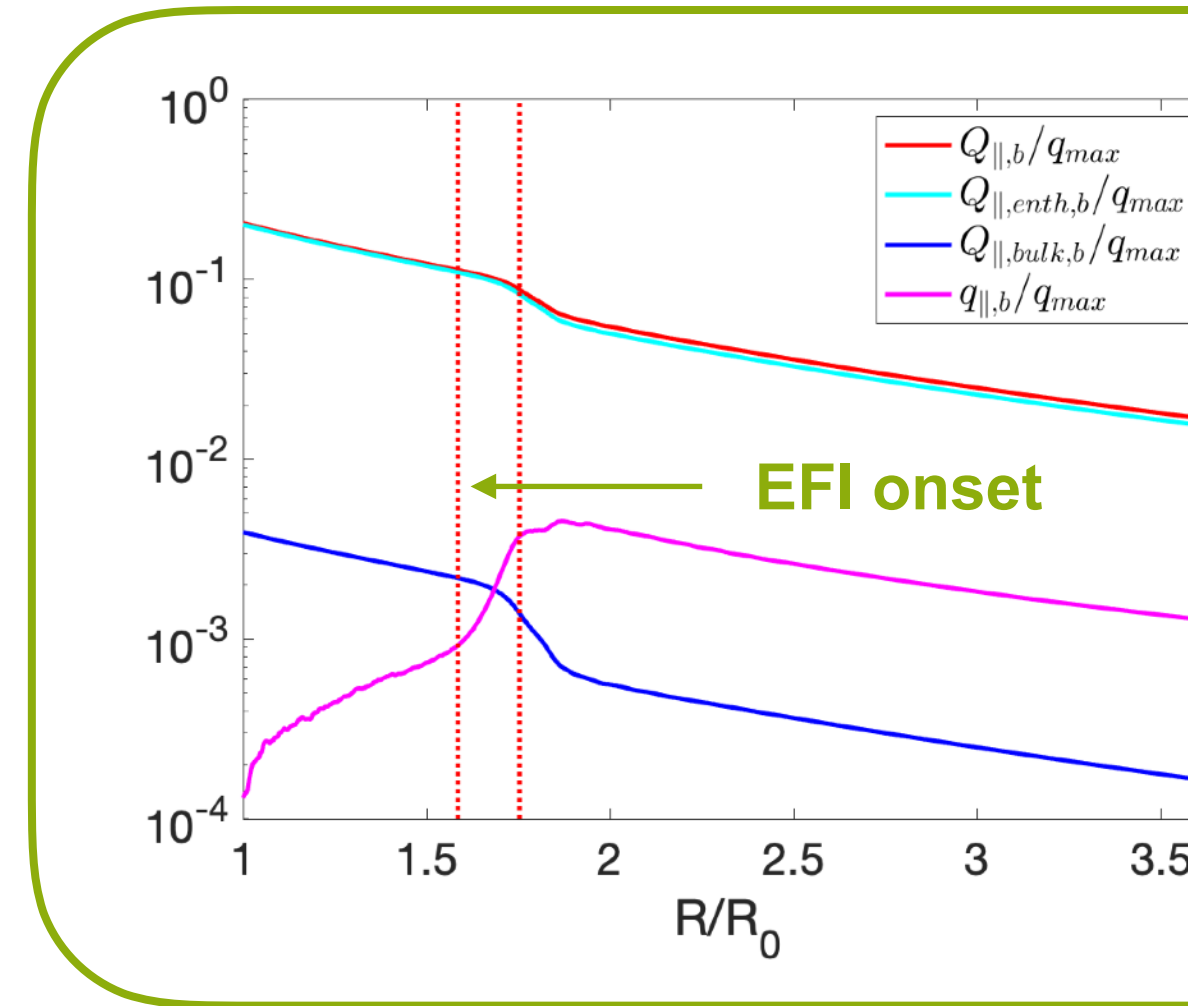
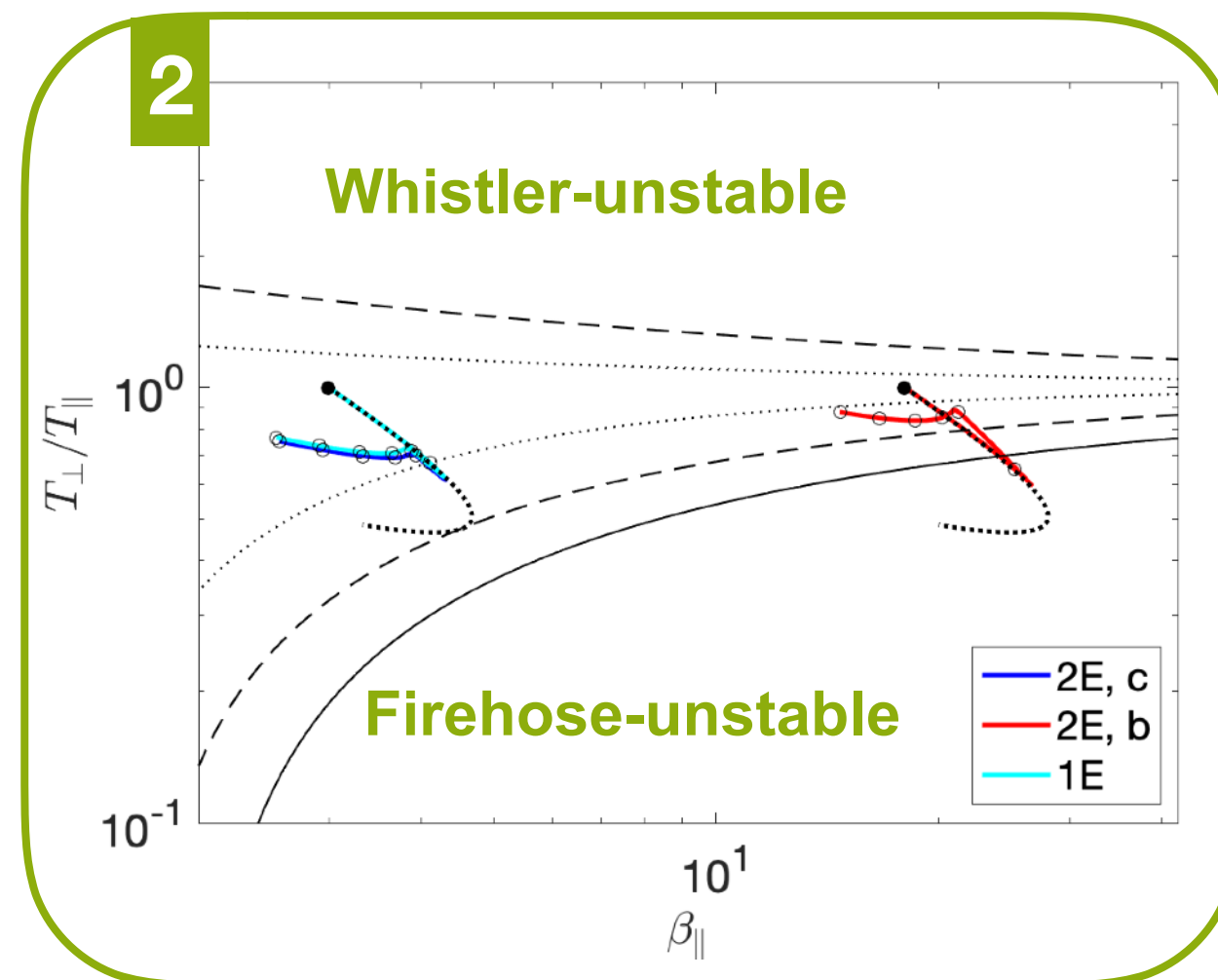
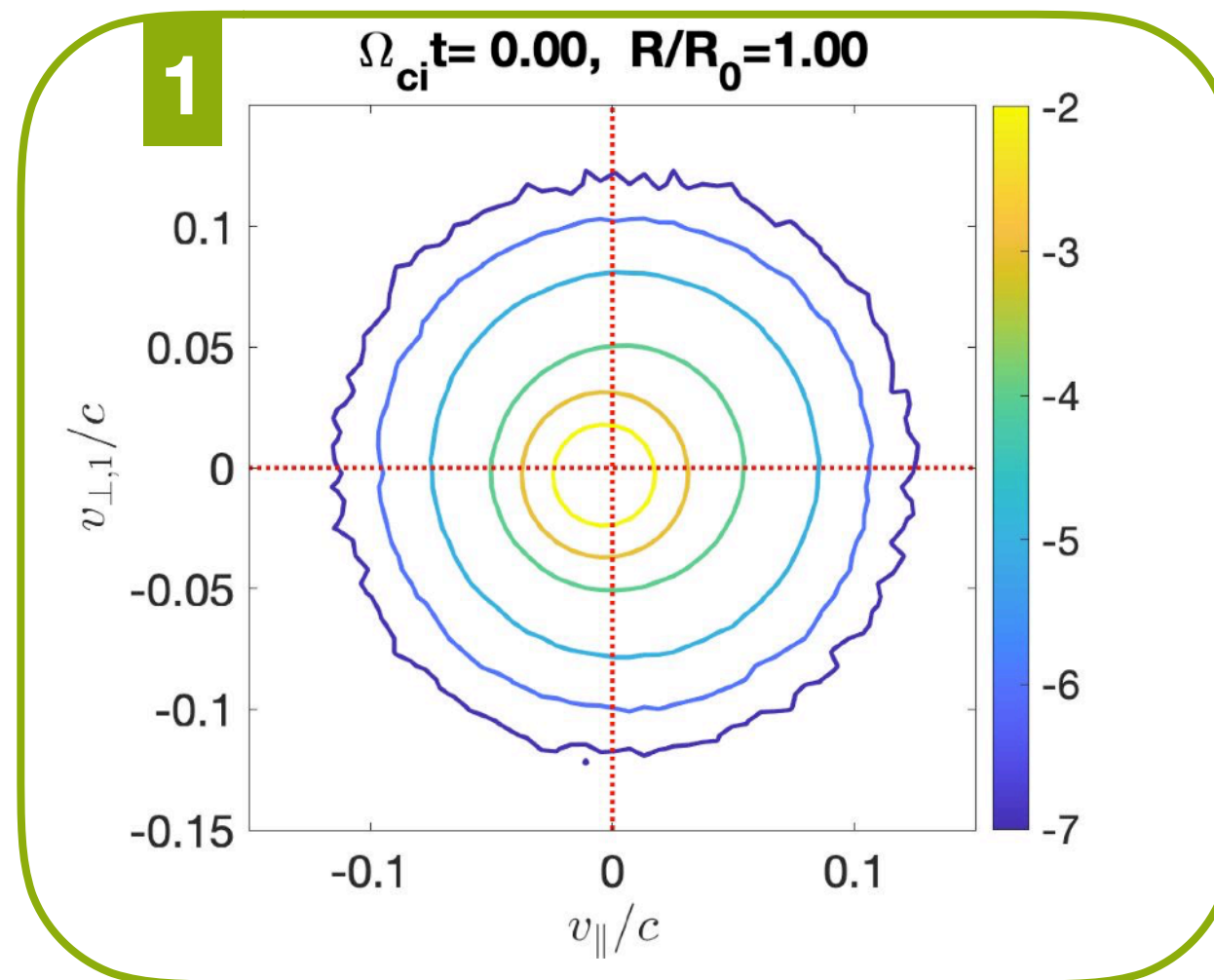


Motivations

1. Collisionless instabilities contribute to heat flux regulation in the solar wind [Scime+ 1994; Halekas+ 2020]
2. Solar wind plasma expansion triggers the onset/ modifies the evolution of collisionless instabilities [Stverak+ 2008; Matteini+ 2013]
3. Can solar wind plasma expansion contribute to heat flux regulation **indirectly**, by triggering or modifying the evolution of heat-flux regulating instabilities [1]?

Method

1. We perform a 1D3V fully kinetic **Expanding Box Model** simulation with the EB-iPic3D code [2], where the electrons have a two-population distribution composed by a **cold, dense core** and a **hot, thin suprathermals**
2. Because of the expansion embedded in the code, an oblique **electron firehose instability** (EFI) is triggered
3. We examine the evolution of the simulated **heat flux**



3

$$Q_s = m_e/2 \int \mathbf{v} v^2 f d^3v =$$

$$n_s \mathbf{V}_{d,s} (3/2 T_{\parallel} + T_{\perp}) + m_e/2 n_s \mathbf{V}_{d,s} V_{d,s}^2 + \mathbf{q}_s =$$

$$Q_{enth} + Q_{bulk} + \mathbf{q}_s$$

$$\mathbf{q}_s = m_e/2 \int \mathbf{w} w^2 f d^3v \quad \mathbf{w} = \mathbf{v} - \mathbf{V}_d$$

Conclusions & future work

1. We observe a **reduction of the simulated heat flux**, with respect to the evolution expected from adiabatic expansion, in correspondence with the **onset of the EFI**
2. We conclude that **expansion can indeed contribute to heat flux regulation indirectly**, by modifying the evolution of heat-flux regulating instabilities
3. In future work, we will examine the role of expansion in modifying the evolution of whistler heat flux instabilities [Micera et al, in preparation]

References

- [1] Innocenti+ 2020, ApJL 898 L41
<https://doi.org/10.3847/2041-8213/aba591>
 [2] Innocenti+ 2019, ApJ 870 66
<https://doi.org/10.3847/1538-4357/aaf1be>