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« A -8/3 spectrum in EMHD turbulence »

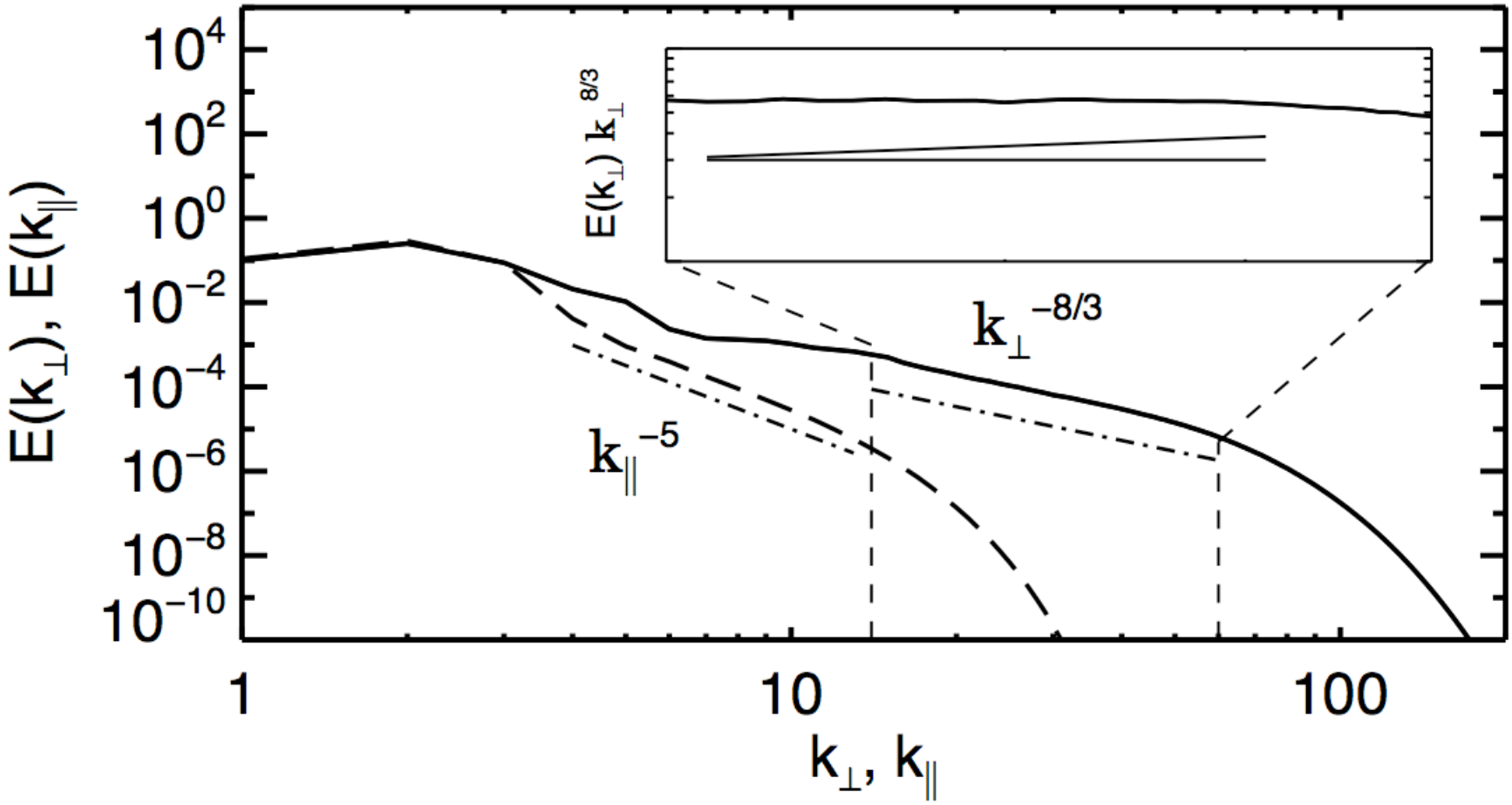
$$\partial_t \mathbf{b} + b_0 \partial_{\parallel} (\nabla \times \mathbf{b}) = -\nabla \times [(\nabla \times \mathbf{b}) \times \mathbf{b}]$$

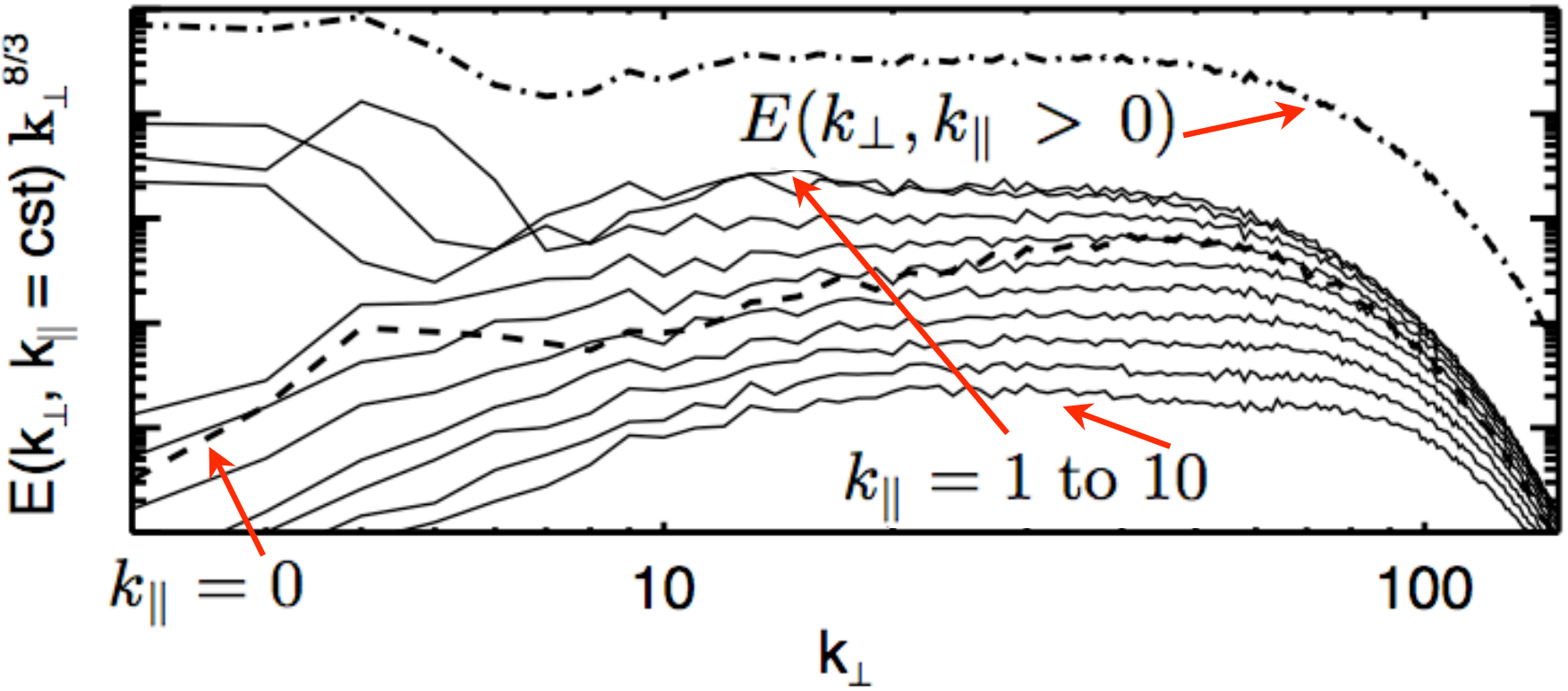
Critical balance regime: $\tau_w \sim \tau_{nl}$

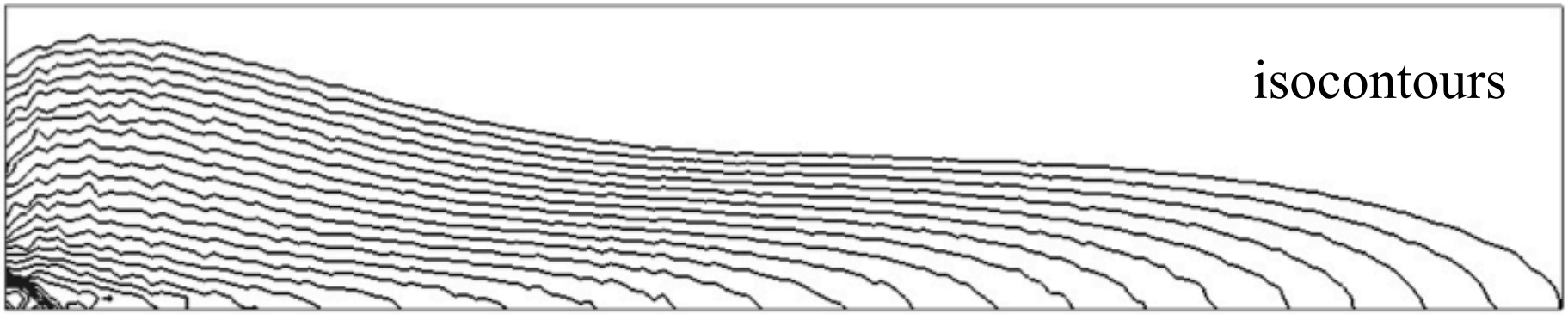
$$E(k_\perp) \sim \varepsilon^{2/3} k_\perp^{-7/3} \qquad E(k_\parallel) \sim \varepsilon^{2/3} k_\parallel^{-5}$$

3D DNS : $b_0 = 15$, $512^2 \times 64$ $> 200,000$ hours of CPU time

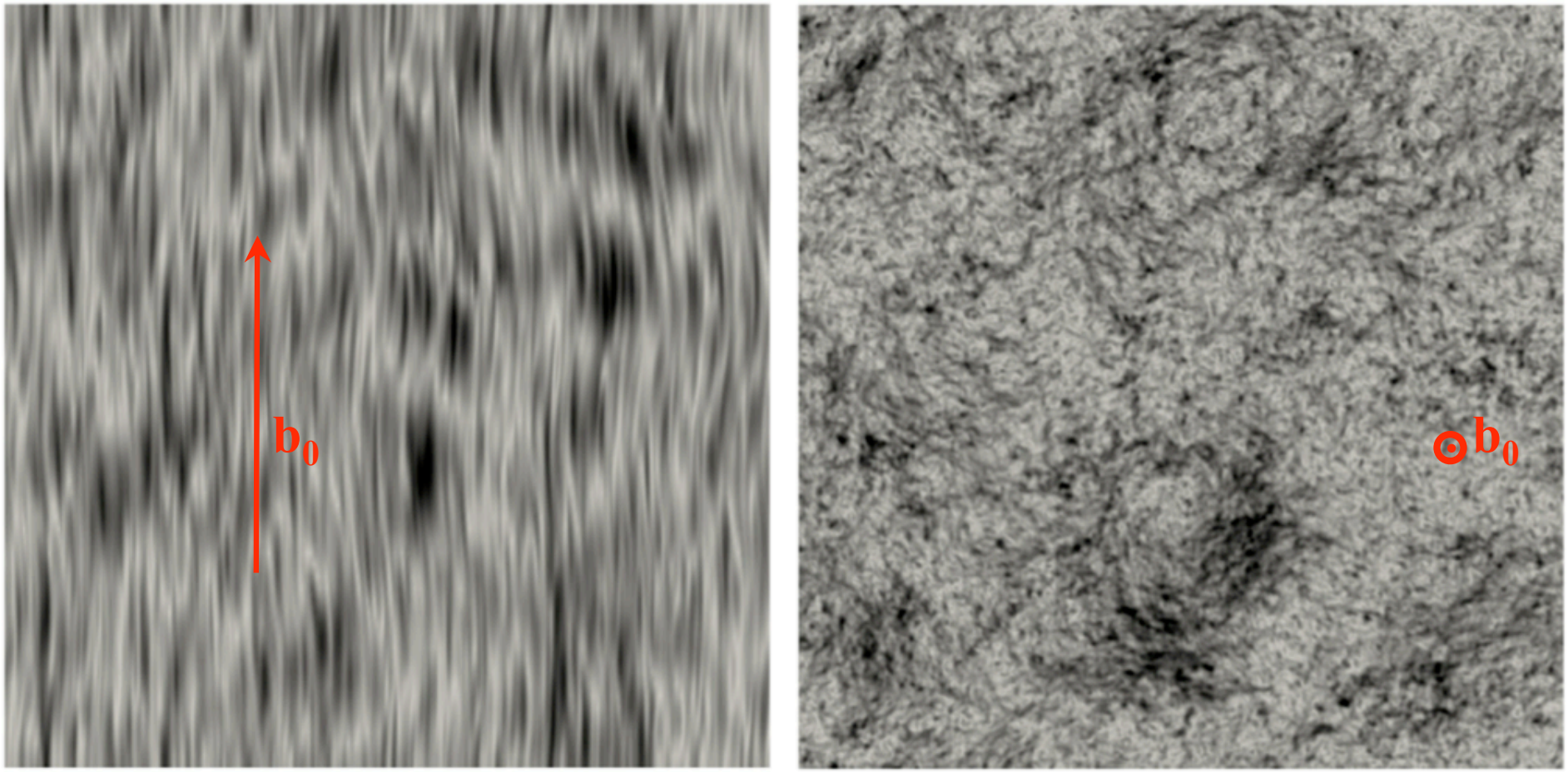
Inertial range : $k_\parallel^D \leq k_\perp \leq k_\perp^D$




E(k⊥, k∥ = cst) k⊥^8/3
E(k⊥, k∥ > 0)
k∥ = 1 to 10
k∥ = 0
10
100
k⊥


isocontours

Norm of the electric current



Hair-like structures

≠ KAW structures [Boldyrev & Perez, 2012]

Heuristic explanation **[Galtier, Pouquet, Mangeney, PoP, 2005]:**

$$E(k_\perp, k_\parallel) \sim k_\perp^{-\alpha} k_\parallel^{-\beta}$$

- $\varepsilon \sim \dfrac{E}{\tau_{nl}^2/\tau_w} \sim \dfrac{E^2 k_\perp^3}{k_\parallel b_0} \sim \dfrac{k_\perp^{-2\alpha+5} k_\parallel^{-2\beta+1}}{b_0}$ $\Rightarrow$ $k_\parallel \sim (\varepsilon b_0)^{1/(-2\beta+1)} k_\perp^{(-2\alpha+5)/(2\beta-1)}$

- $\chi = \dfrac{\tau_w}{\tau_{nl}} = \dfrac{k_\perp b}{k_\parallel b_0} = \text{"constant"}$ $\Rightarrow$ $\chi \sim \dfrac{1}{b_0} k_\perp^{(-\alpha+3)/2} k_\parallel^{-(\beta+1)/2}$

  $\Rightarrow$ $k_\parallel \sim (\chi b_0)^{-2/(\beta+1)} k_\perp^{(-\alpha+3)/(\beta+1)}$

$$3\alpha + \beta = 8$$

Strong (7/3,1) and weak (5/2,1/2) turbulence predictions are recovered

If: $\beta = 0$ then: $\alpha = 8/3$ (bidimensional dynamics)

→ *Meyrand & Galtier, 2013*