Chapter 5

The Black Hole Gap Emission: General argument

§1 BH gaps for various BH masses

§2 Poleward-enhanced emission at high BH spin

§ 1 BH gaps for various BH masses

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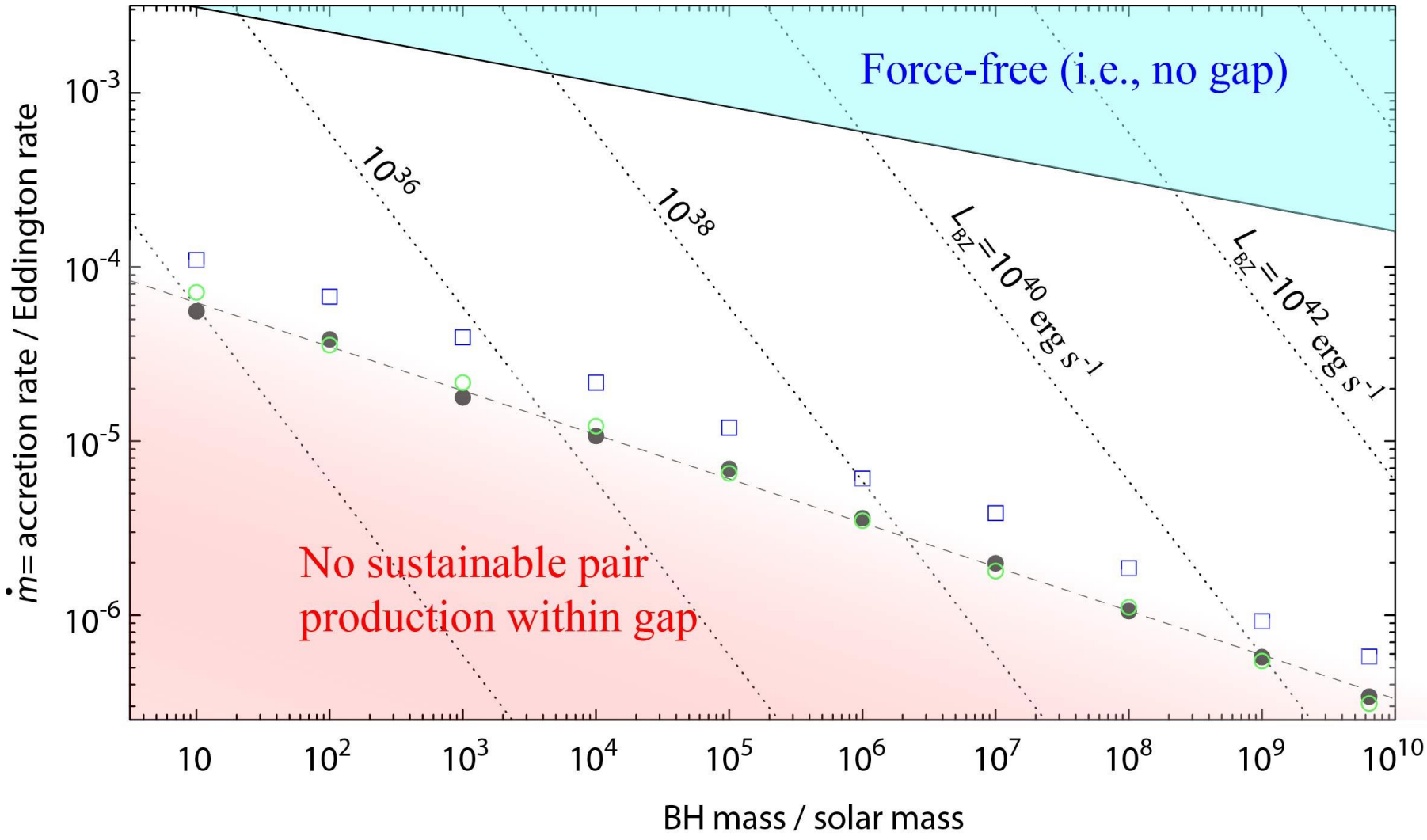
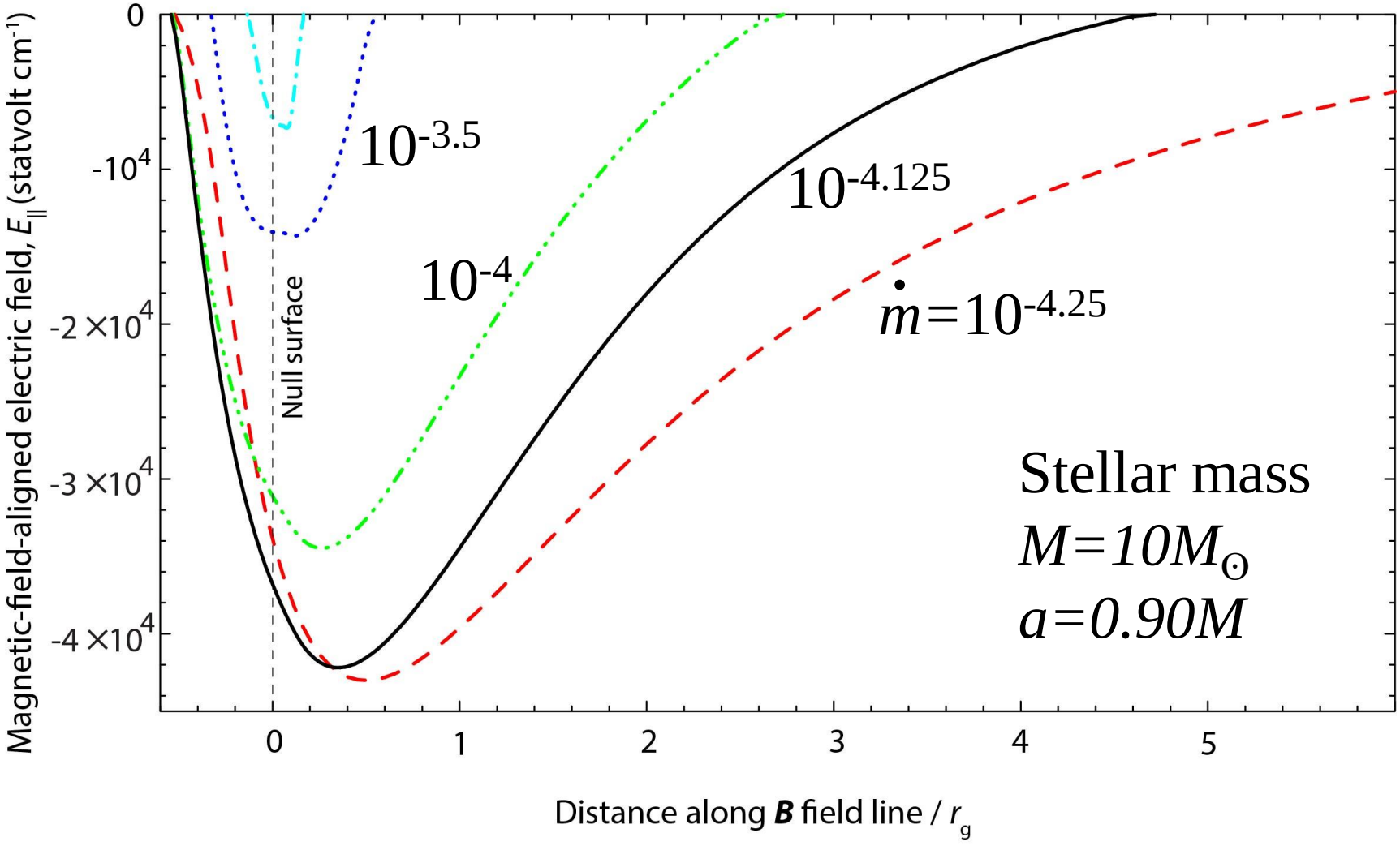
BH gap exists for various BH masses.



KH + (2016, ApJ 833, 142)

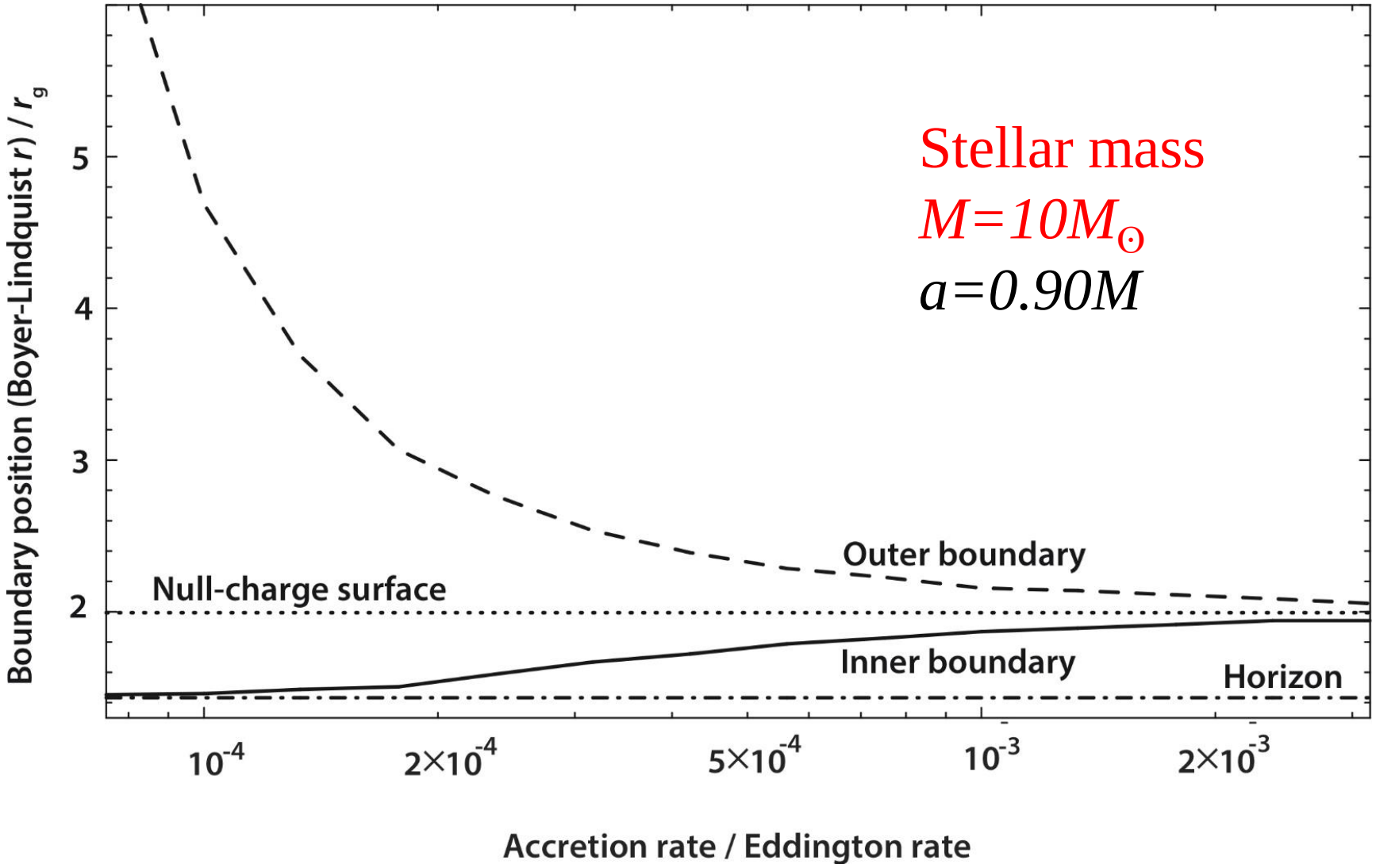
§ 1 BH gaps for various BH masses

$E_{\parallel}$ and potential drop increase with decreasing $\dot{m}$.



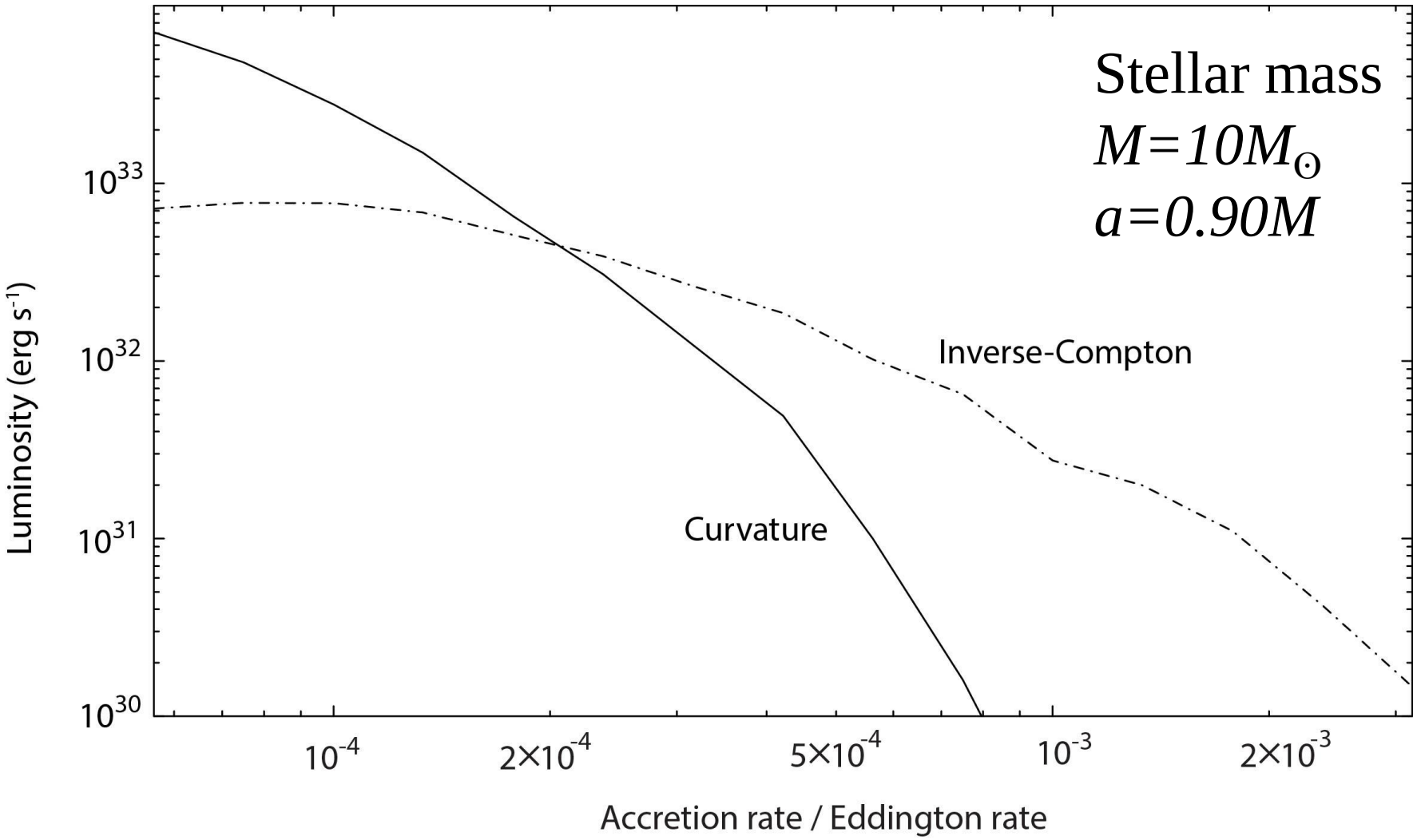
§ 1 BH gaps for various BH masses

Gap longitudinal width increases with decreasing $\dot{m}$.



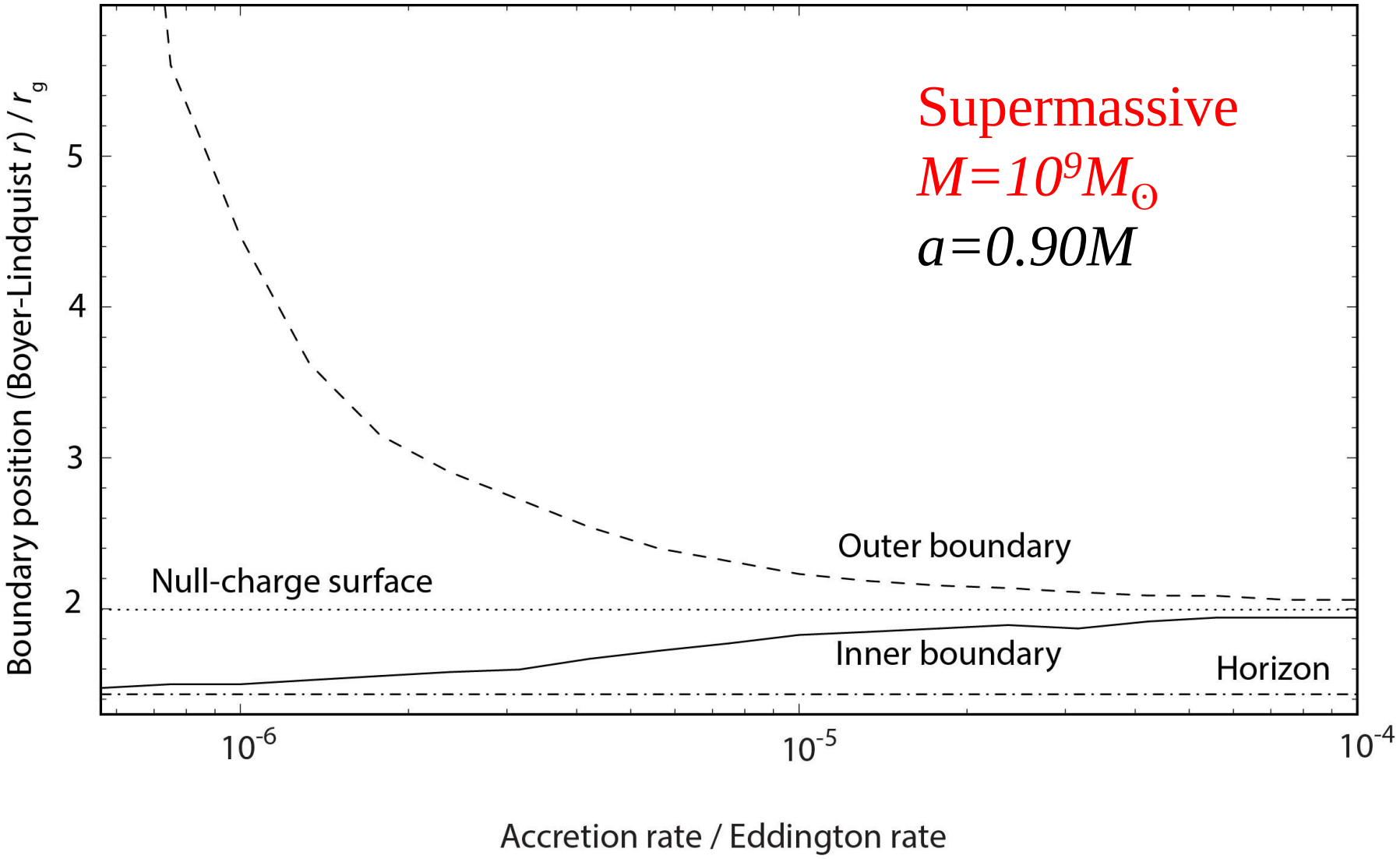
§ 1 BH gaps for various BH masses

Curvature process dominates IC process at smaller $\dot{m}$.



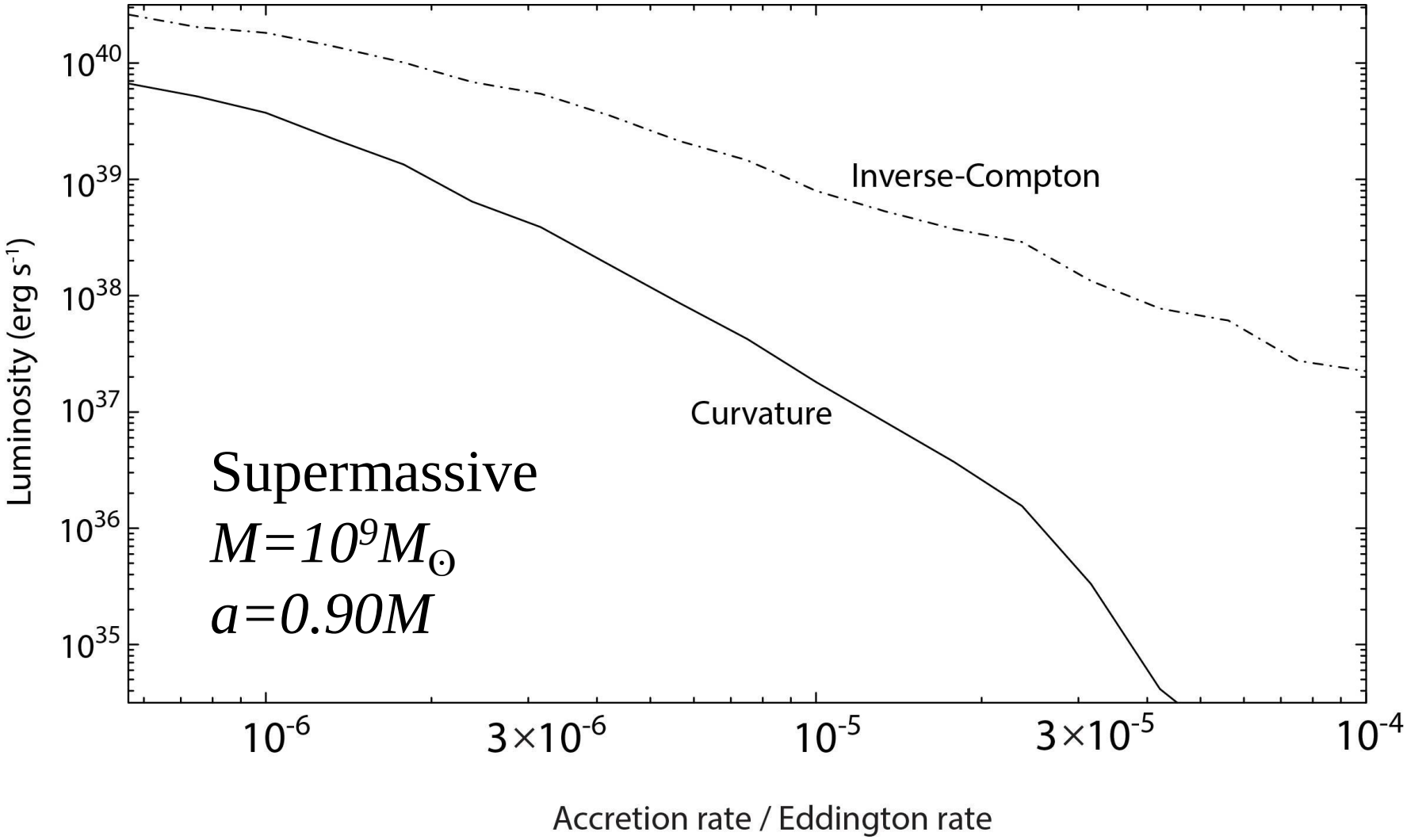
§ 1 BH gaps for various BH masses

Gap electrodynamics is unchanged when M varies.



§ 1 BH gaps for various BH masses

However, IC process dominates curvature one at all $\dot{m}$.

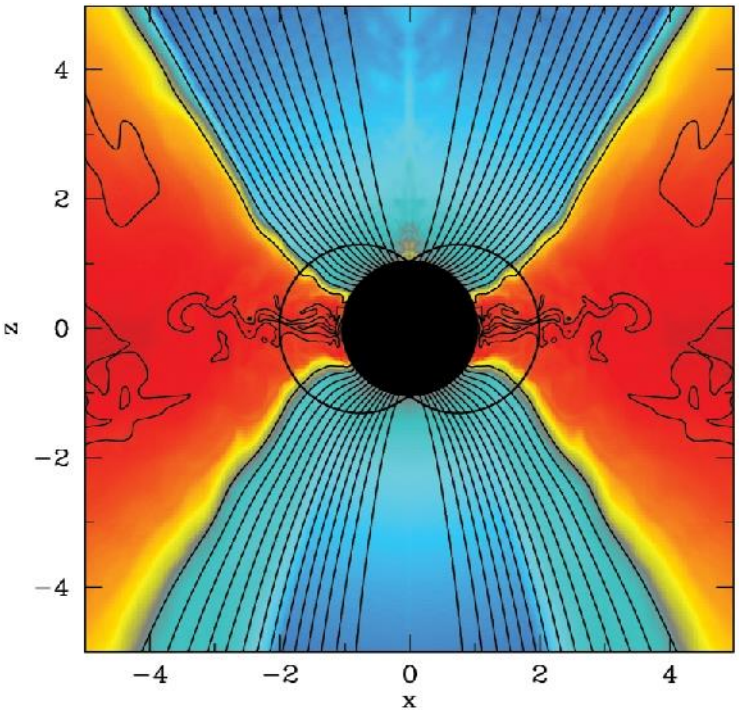


§ 2 Emission enhancement along the rotation axis as BH spins up

§ 2 Poleward enhanced emission at $a \rightarrow M$

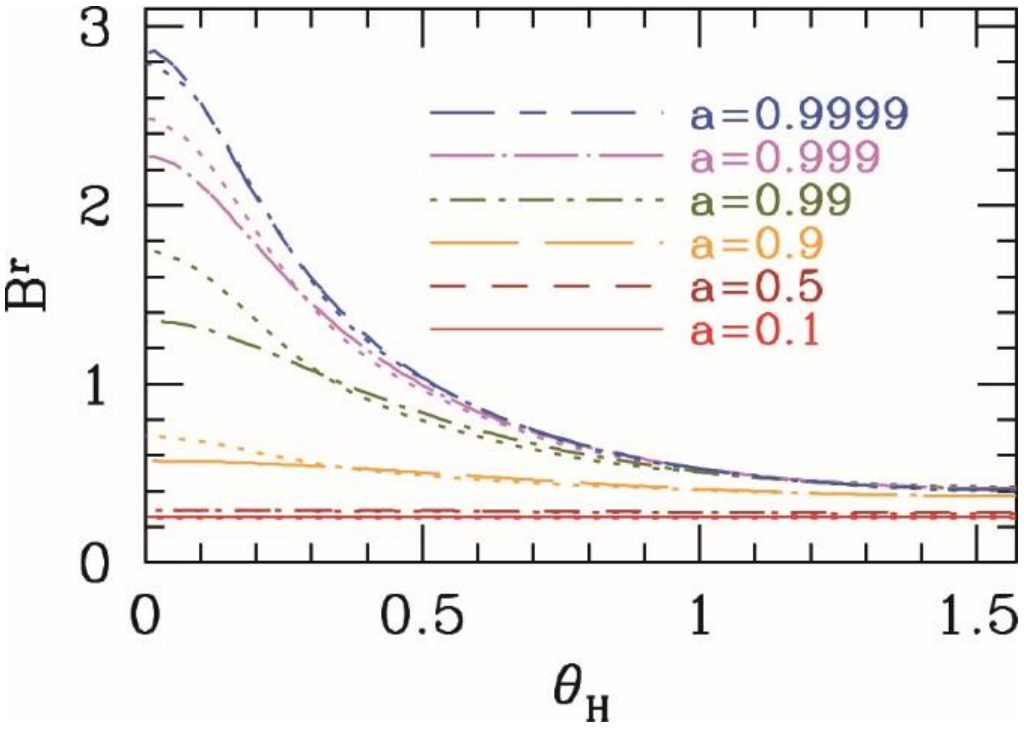
Let us start with the effect of poleward concentration of $\boldsymbol{B}$.

As $a \rightarrow M$, $\boldsymbol{B}$ field lines laterally rearrange to concentrate toward the rotation axis.



Komissarov & McKinney 2007, MNRAS 377, L49

$B^r{}_{\rm H}(\theta;a)$



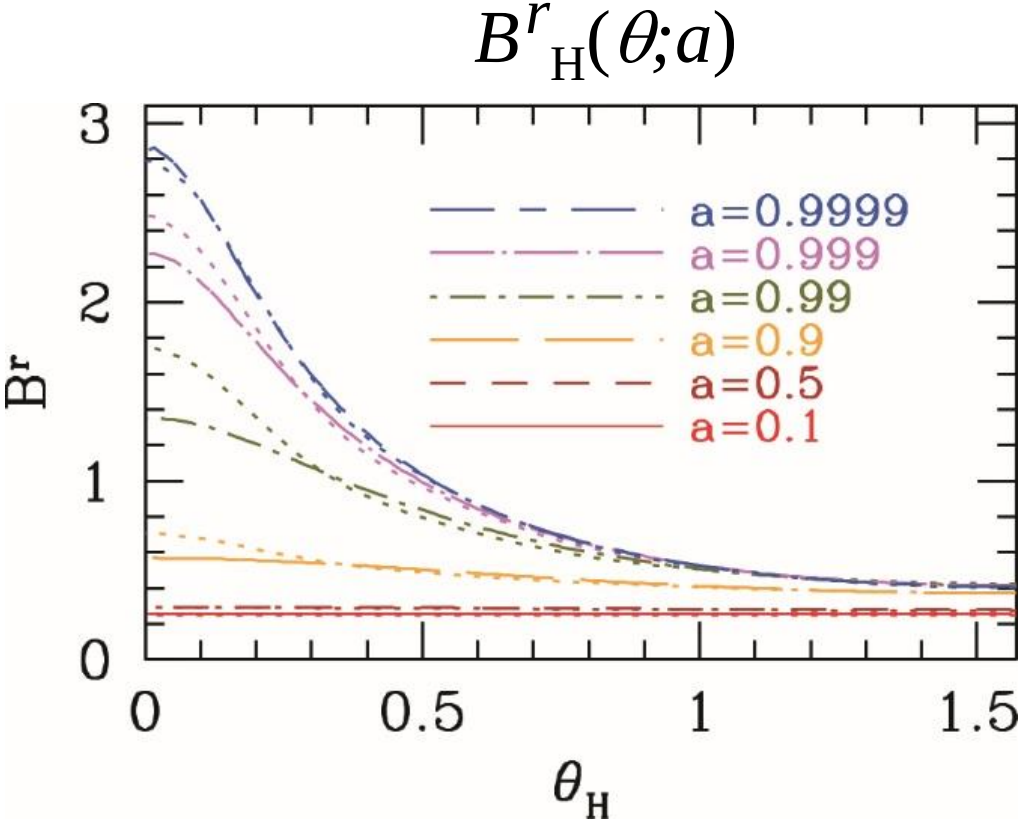
Tchekhovskoy + 2010, ApJ 711, 50

§ 2 Poleward enhanced emission at $a \to M$

Let us start with the effect of poleward concentration of $\boldsymbol{B}$.

As $a \to M$, $\boldsymbol{B}$ field lines laterally rearrange to concentrate toward the rotation axis.

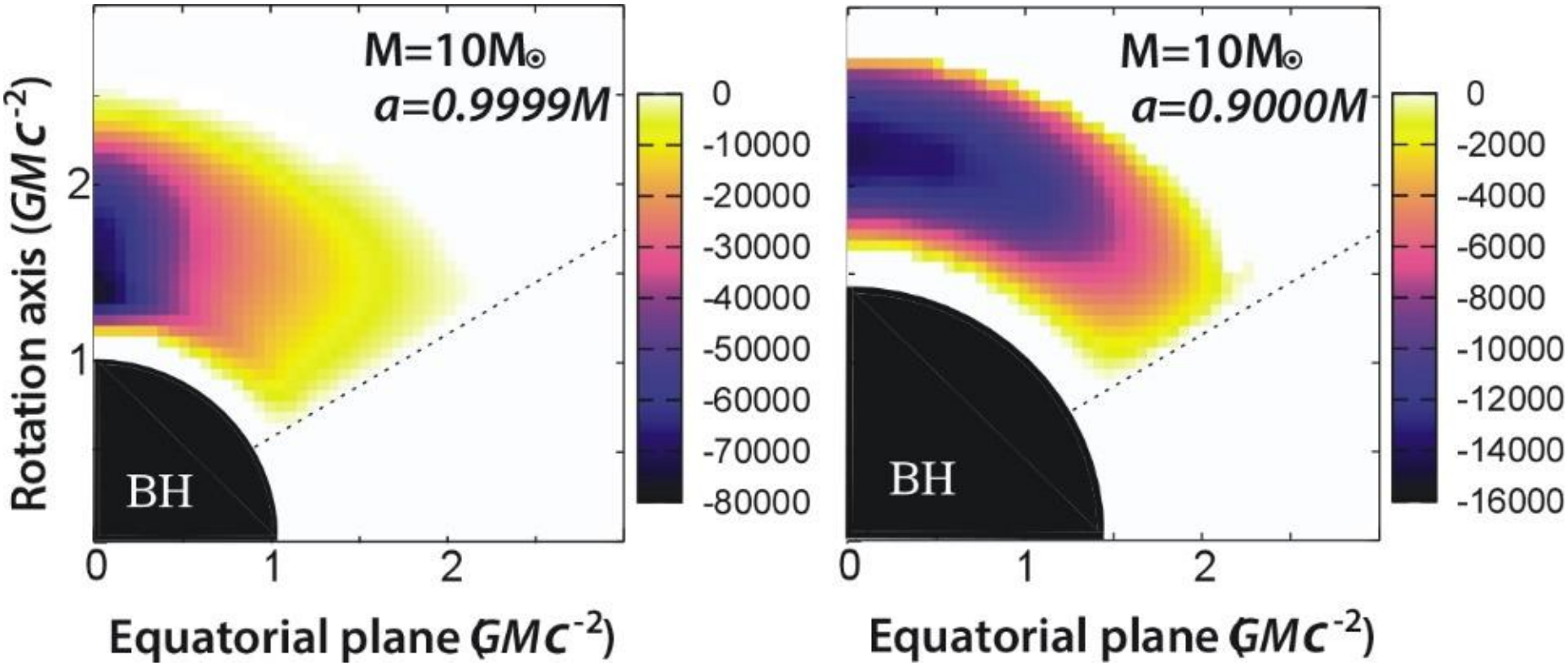
Because of this poleward concentration of $B^r{}_{\rm H}$, BZ power ($\propto B_H^{r\,2}$), and hence the gap emissivity increases toward the rotation axis.



Tchekhovskoy + 2010, ApJ 711, 50

§ 2 Poleward enhanced emission at $a \to M$

$E_{\parallel}$ concentrates poleward when BH rotates extremely.

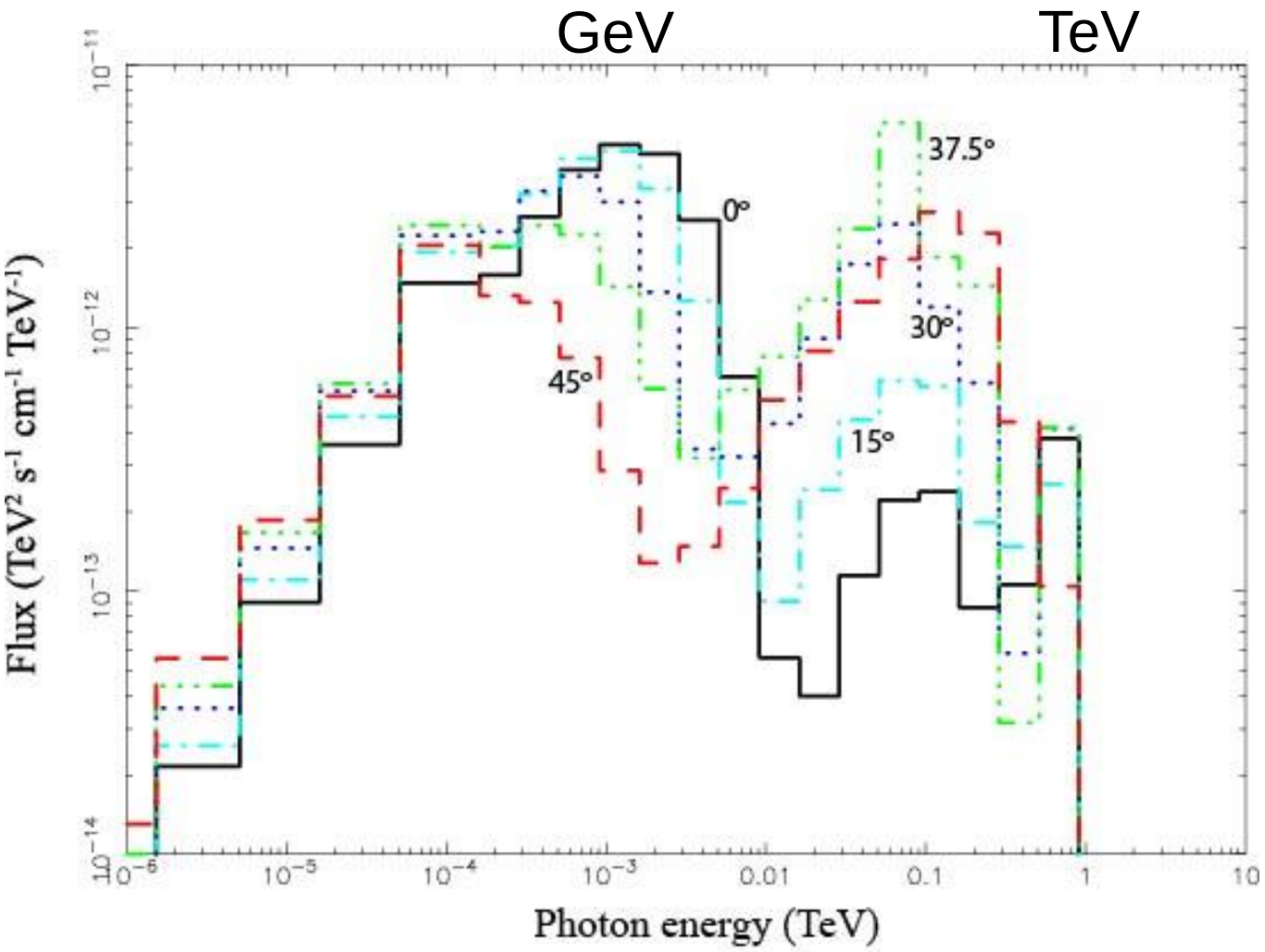


§ 2 Poleward enhanced emission at $a \to M$

$M=10M_{\odot}$, $B=B_{eq}$; SEDs @ five discrete θ ($\dot{m}=7.5\times10^{-5}$)

$a=0.9999M$

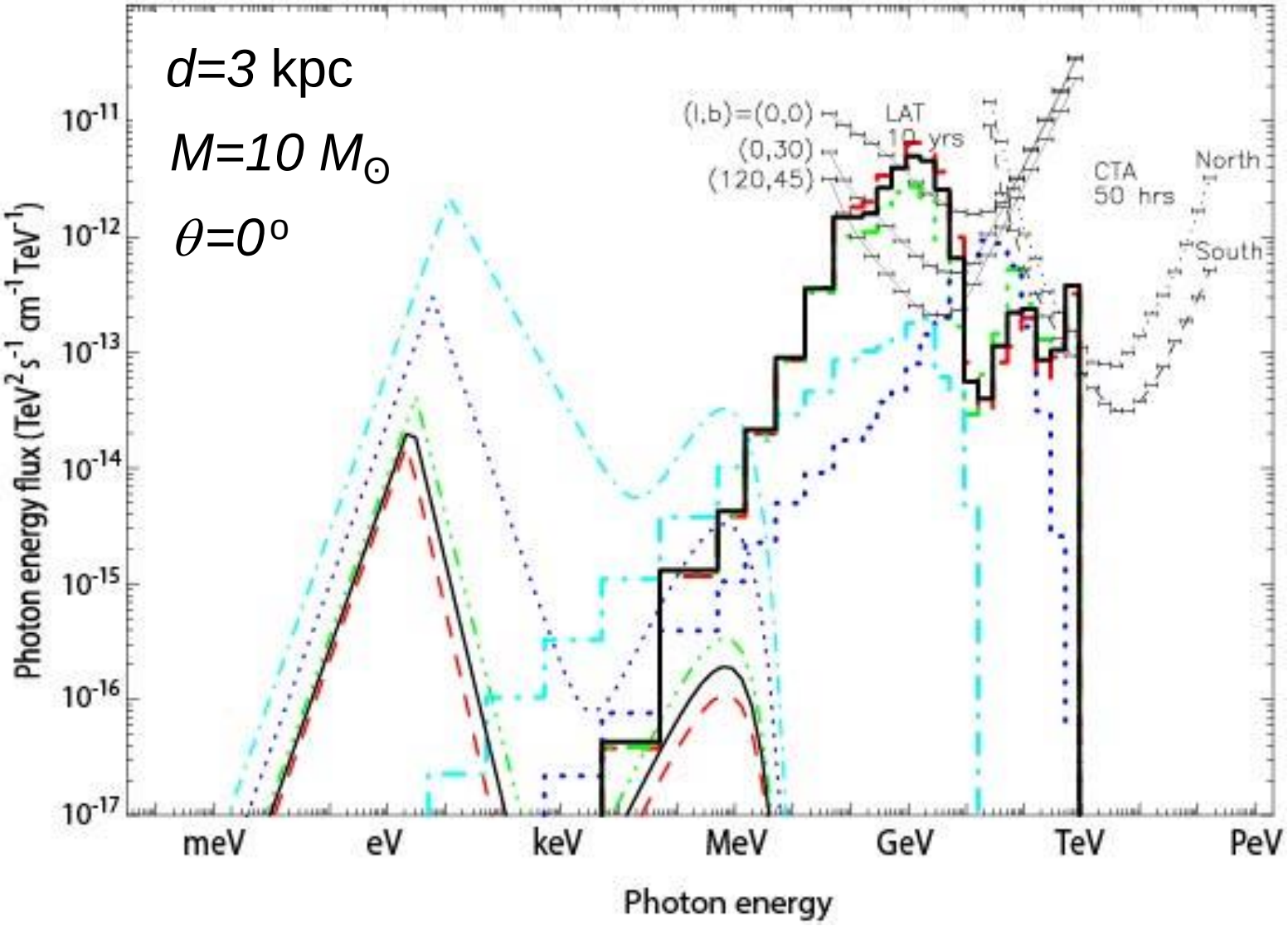
HE flux peaks along ***B*** axis, while VHE flux does along middle latitudes.



Yoogeun Song + 2017, MNRAS 471, L135

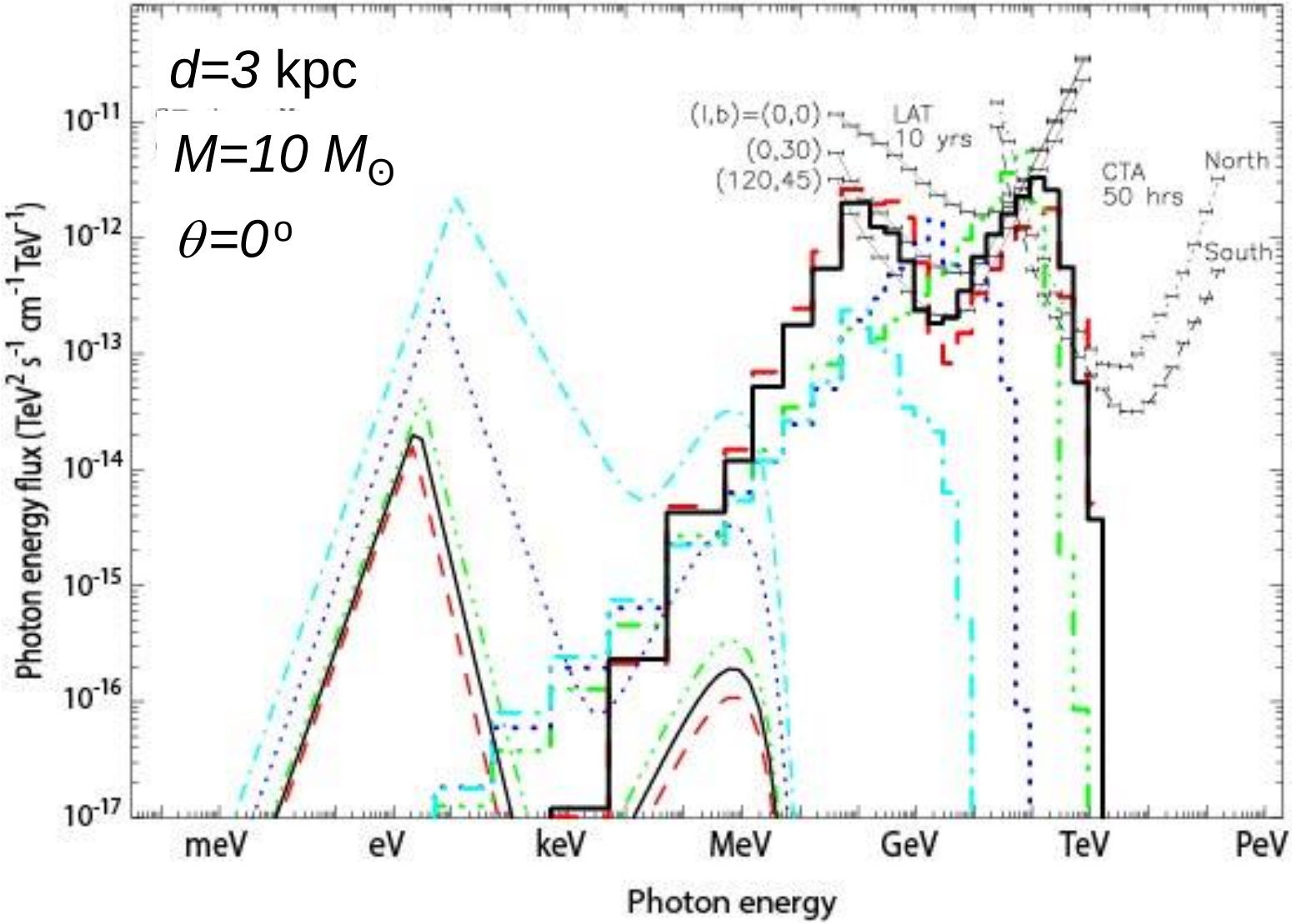
§ 2 Poleward enhanced emission at $a \rightarrow M$

Both HE & VHE fluxes are detectable when $a=0.9999M$.



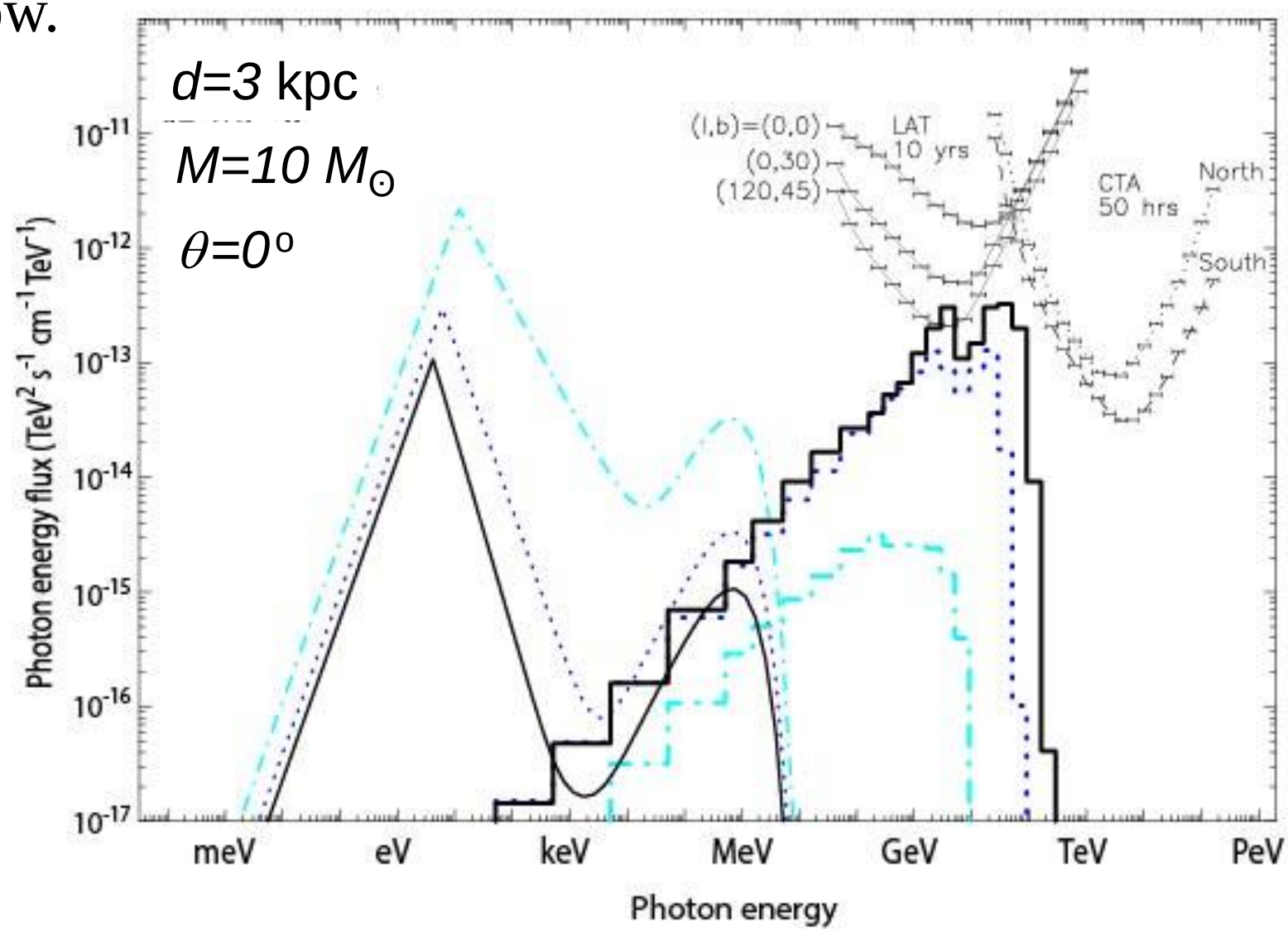
§ 2 Poleward enhanced emission at $a \to M$

VHE flux is detectable w/ CTA for $a=0.9900M$.



§ 2 Poleward enhanced emission at $a \rightarrow M$

Gap emission is hopeless to be detected if $a=0.90M$ or below.



Summary on BH gap model

- When the mass accretion rate is highly sub-Eddington, the polar funnel becomes charge-starved. Gaps appear within a few GM/c^2 above the event horizon.
- The gap emission concentrates toward the rotation axis as $a \rightarrow M$ (Song +, 2017, MNRAS 471, L135).

END OF CHAPTER 5