Cosmic filament spin, boundary and its impact on galaxy spin

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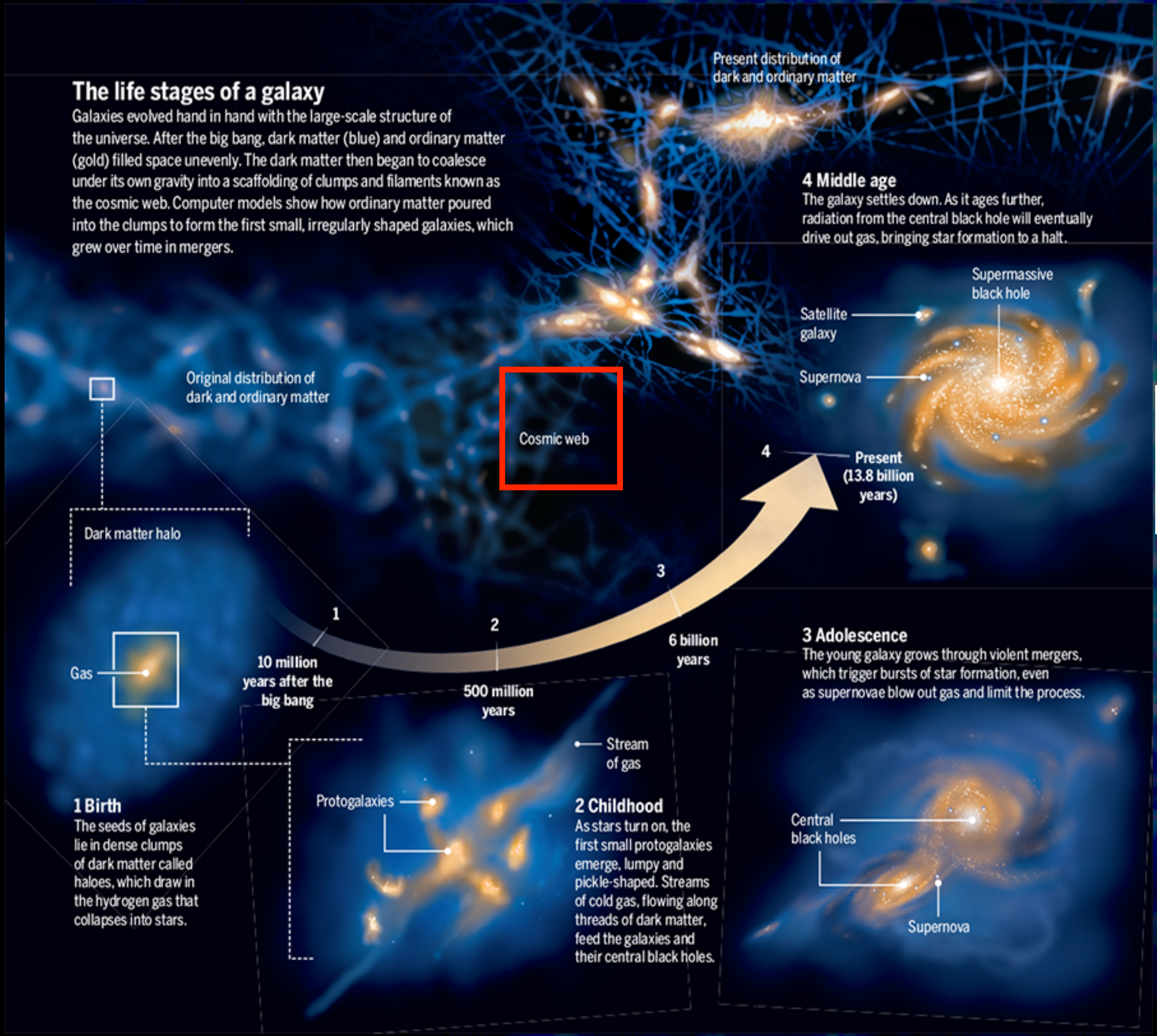
Outline

- Background
- Filament spin
- Filament boundary
- Impact on galaxy spin
- Summary

Why the cosmic web?



Cosmic web is the place galaxy F&E

2014 Estonia The Zeldovich Universe

IAU Symposia

IAUS 308: The Zeldovich Universe: Genesis and Growth of the Cosmic Web

US. Astro2020 White paper

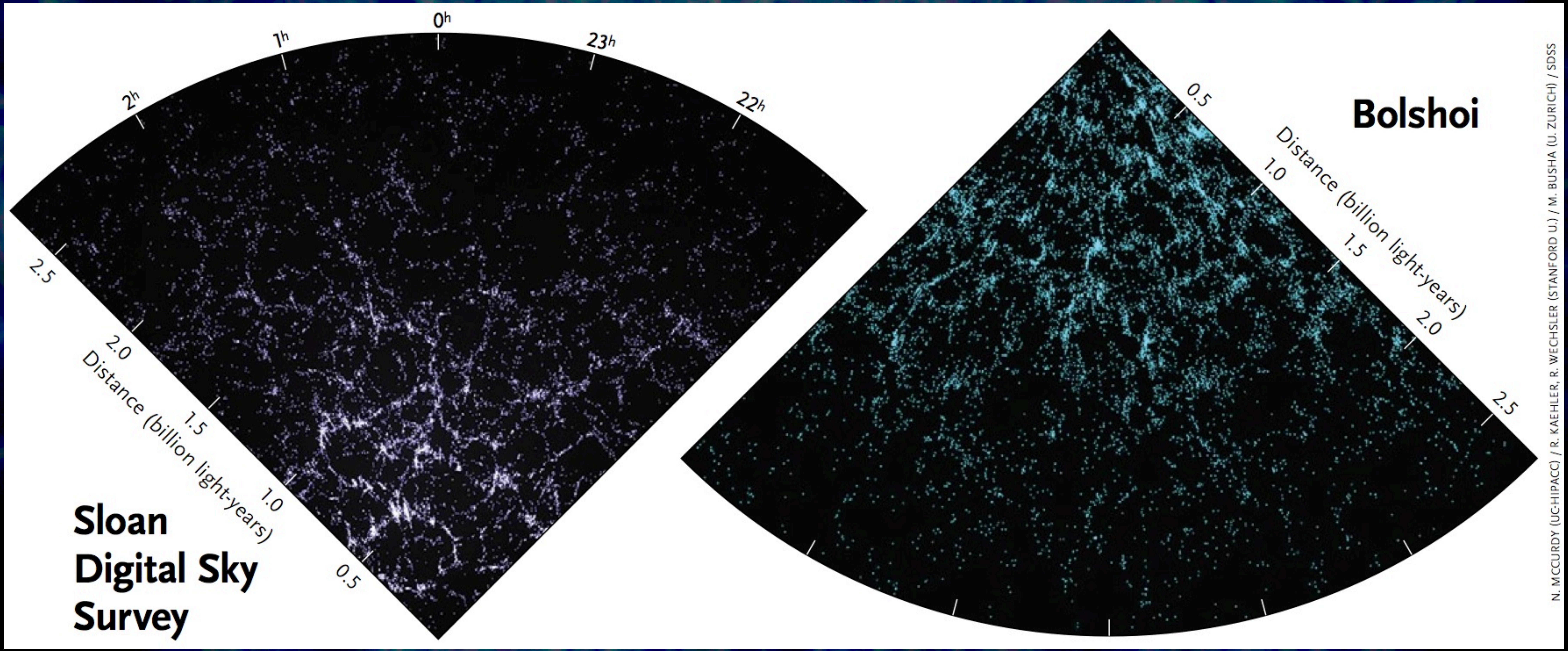
BOX 2.3 Connecting Galaxies to the Cosmic Web

eas 2023 Kraków

SS15 : Cosmic filaments in the Universe

The matter/galaxy distribution in large scale

The Cosmic Web



Galaxy distribution

Halo distribution

Filaments are the most significant structure within CW

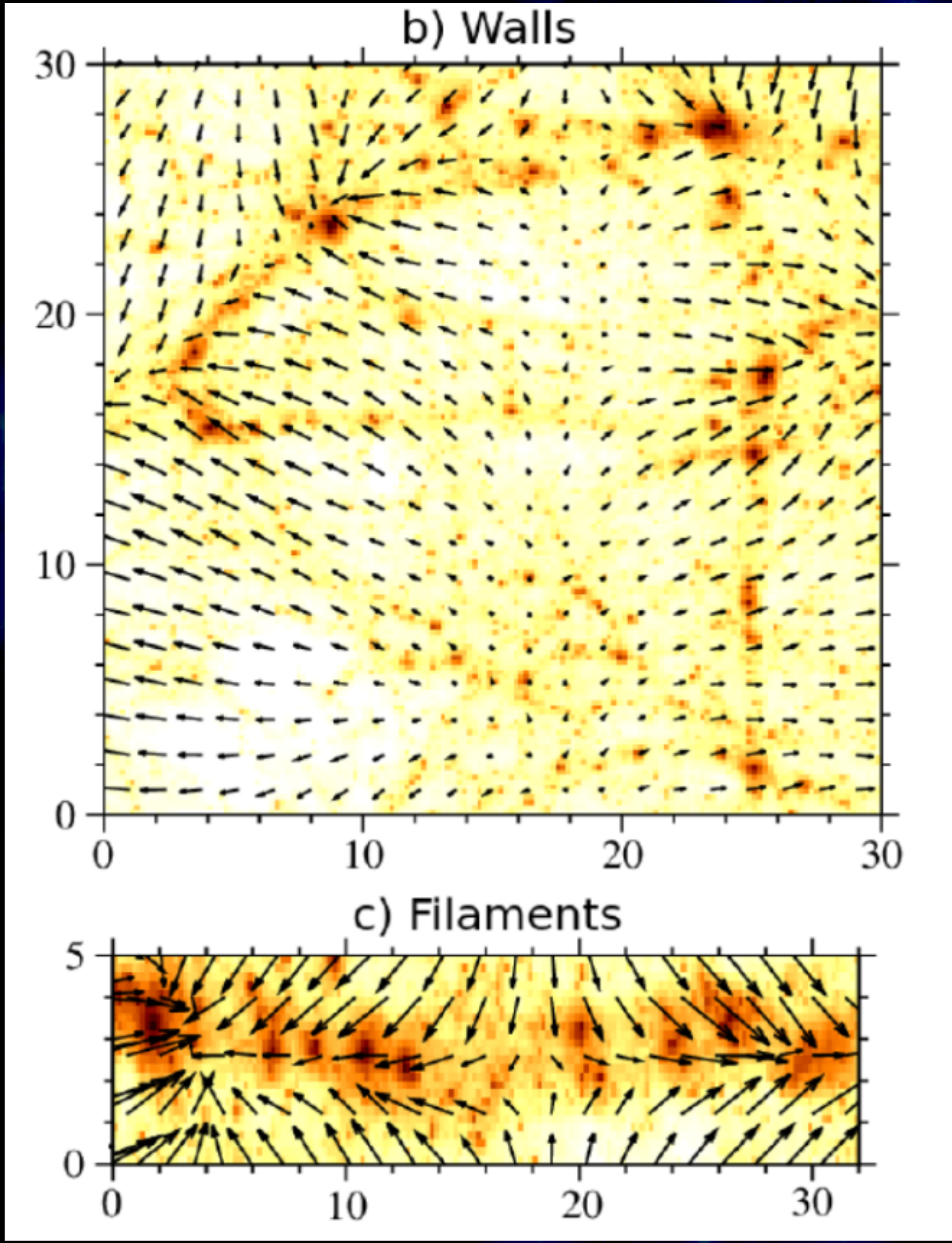
How to describe the cosmic web

Method	Web types	Input	Type	Main references
Adapted minimal spanning tree (MST)	Filaments	Haloes	Graph and percolation	Alpaslan et al. (2014a)
Bisous	Filaments	Haloes	Stochastic	Tempel et al. (2014, 2016)
FINE	Filaments	Haloes	Stochastic	González & Padilla (2010)
Tidal shear tensor (T-web)	All	Particles	Hessian	Forero-Romero et al. (2009)
Velocity shear tensor (V-web)	All	Particles	Hessian	Hoffman et al. (2012)
CLASSIC	All	Particles	Hessian	Kitaura & Angulo (2012)
NEXUS+	All	Particles	Scale-space, Hessian	Cautun et al. (2013)
Multiscale Morphology Filter-2 (MMF-2)	All except knots	Particles	Scale-space, Hessian	Aragón-Calvo et al. (2007a) Aragón-Calvo & Yang (2014)
Spineweb	All except knots	Particles	Topology	Aragón-Calvo et al. (2010c)
DisPerSE	All except knots	Particles	Topology	Sousbie (2011)
ORIGAMI	All	Particles	Phase space	Falck et al. (2012); Falck & Neyrinck (2015)
Multi-Stream Web Analysis (MSWA)	All	Particles	Phase space	Ramachandra & Shandarin (2015)

The main driver of this paper is to quantify in a systematic way both the similarities and differences between cosmic-web finders. There is no well-motivated common framework to objectively define the constituents of the cosmic web, so there is no way of judging which methods are successful or which ones are – in some objective way – 'better'. As such, the goal is to compare the output of the various methods to better relate studies that use different web

Libeskind et al. 2018


Filament spin



Cautun et al. 2014

Mass flow in Walls: laminar motion

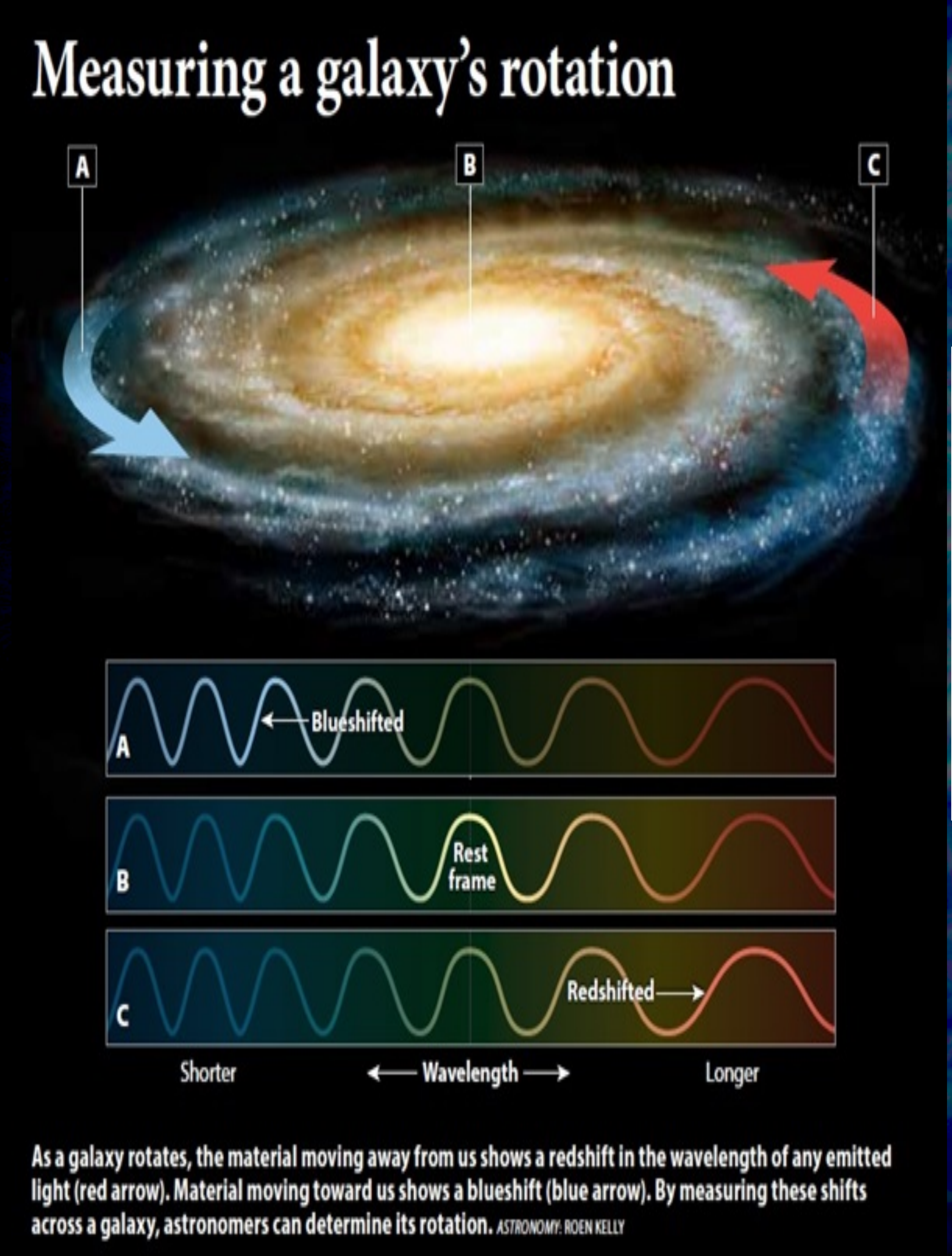
Mass flow in Filaments: helical motion

outer region: prep.

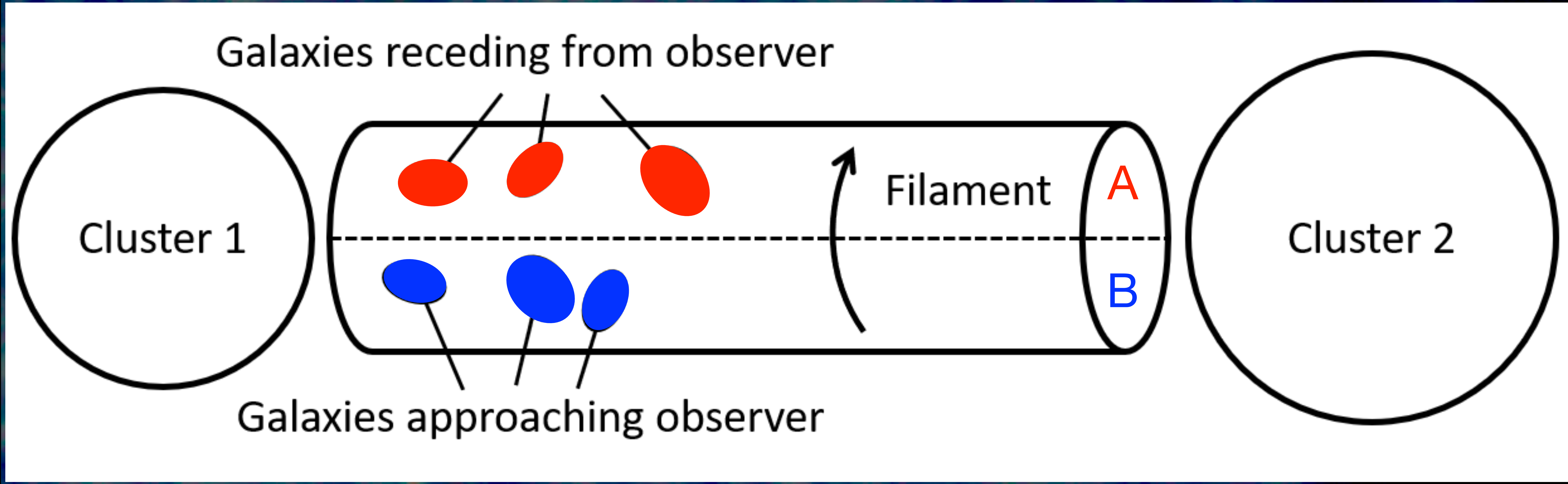
inner region: align

Filaments may have spins

How to measure filament spin



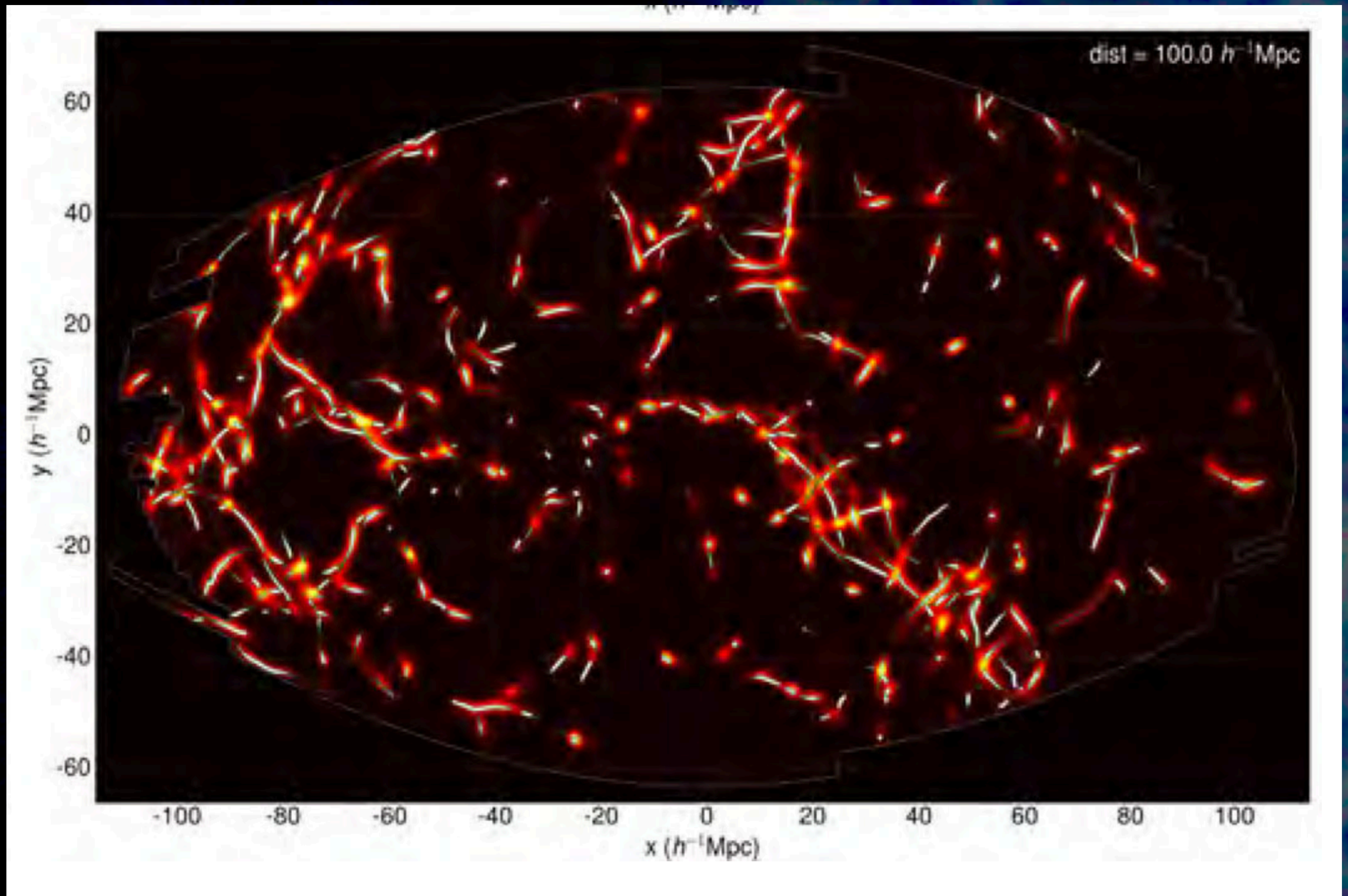
Measure the red/blue shift of
stars
within a galaxy



Credit: Roan Hagger/Abstrobites + Peng Wang

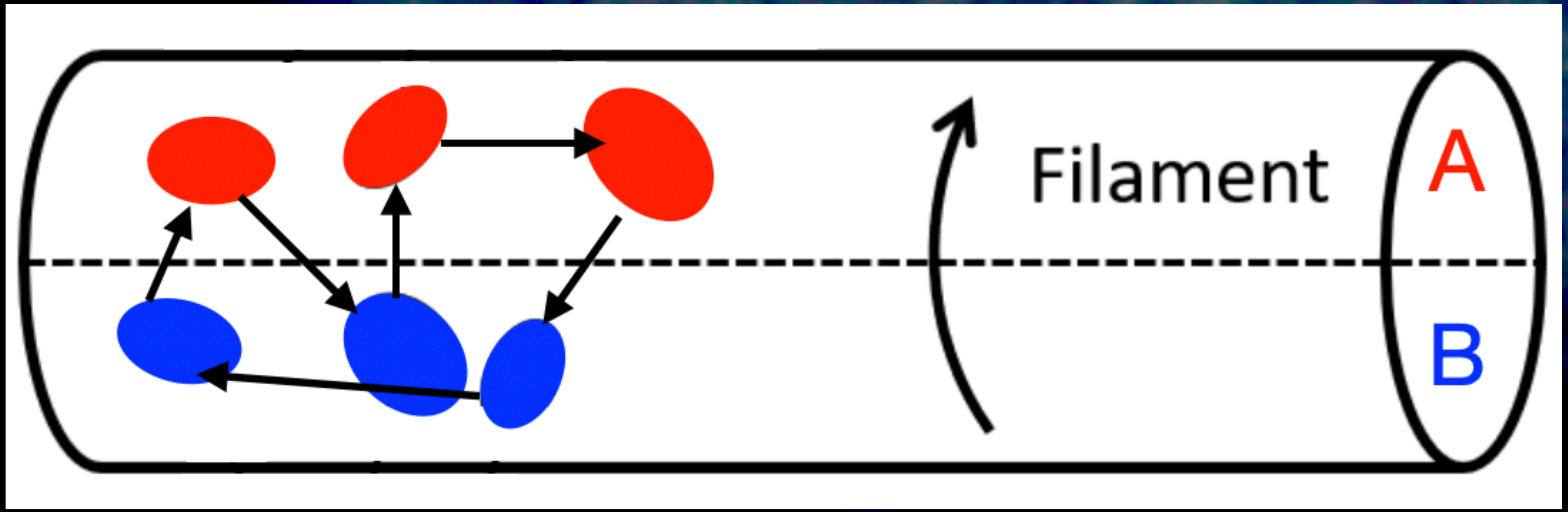
Measure the red/blue shift of
galaxies
within a filament

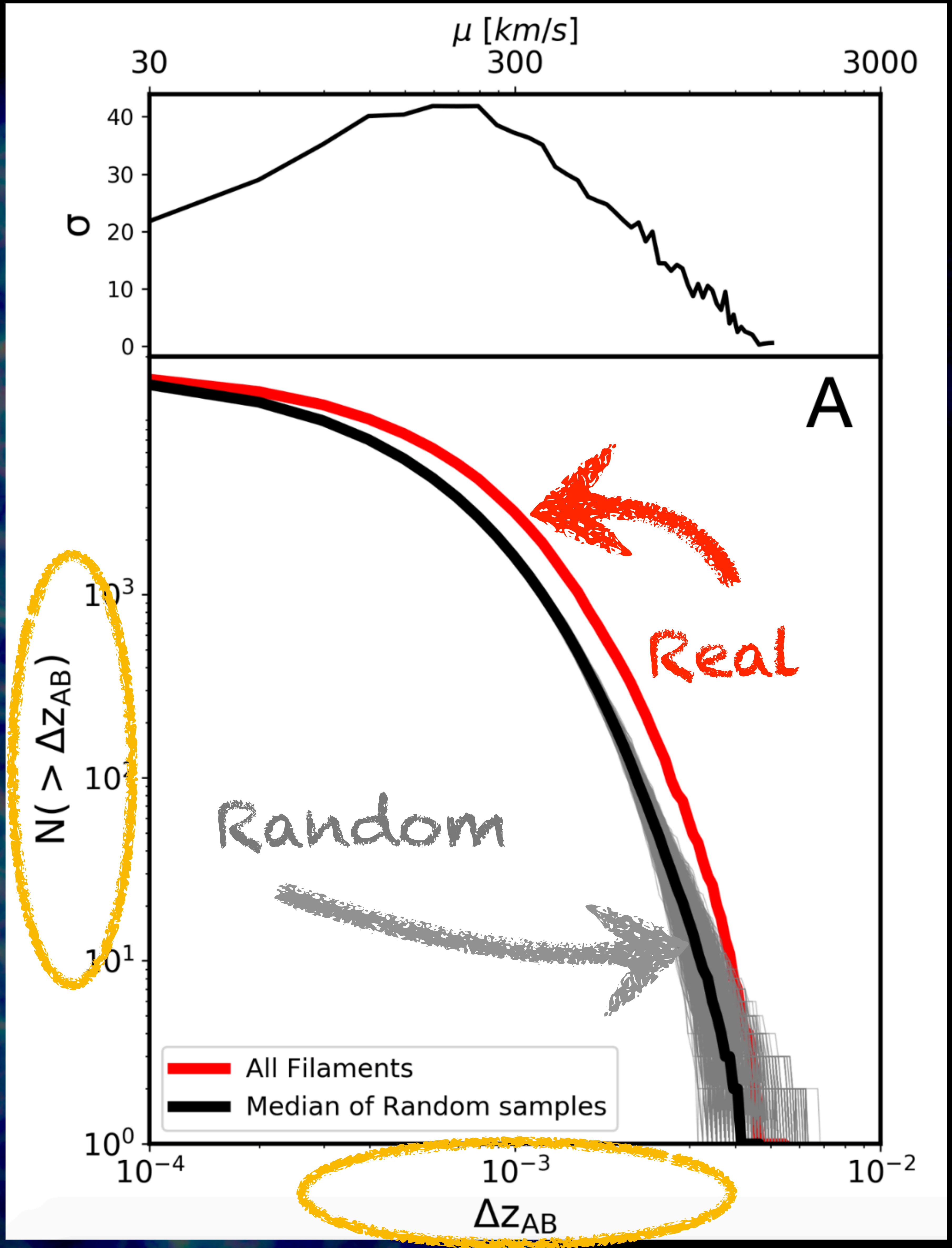
Filament spin signal



SDSS DR12
+
Bisous

Shuffle galaxies redshifts



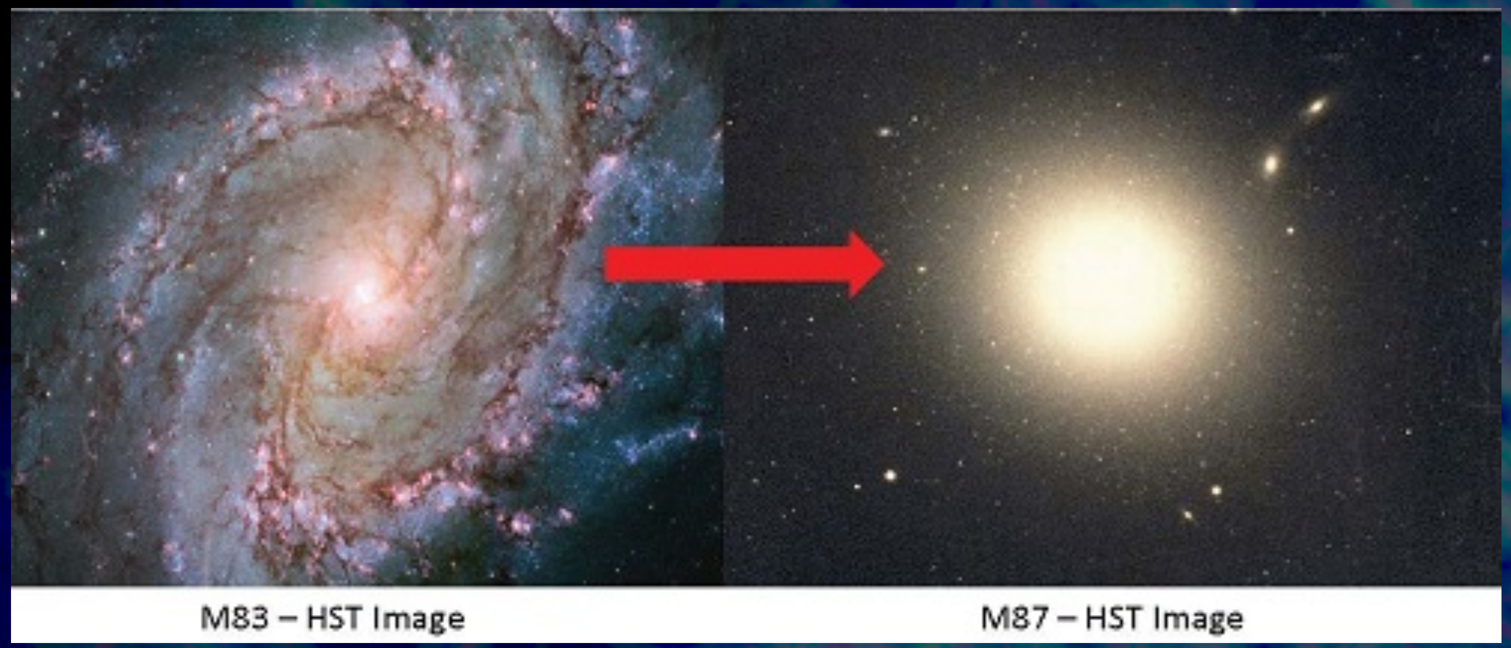


$\Delta Z_{AB} = \langle Z_A \rangle - \langle Z_B \rangle$

Wang et al. Nature Astronomy 2021

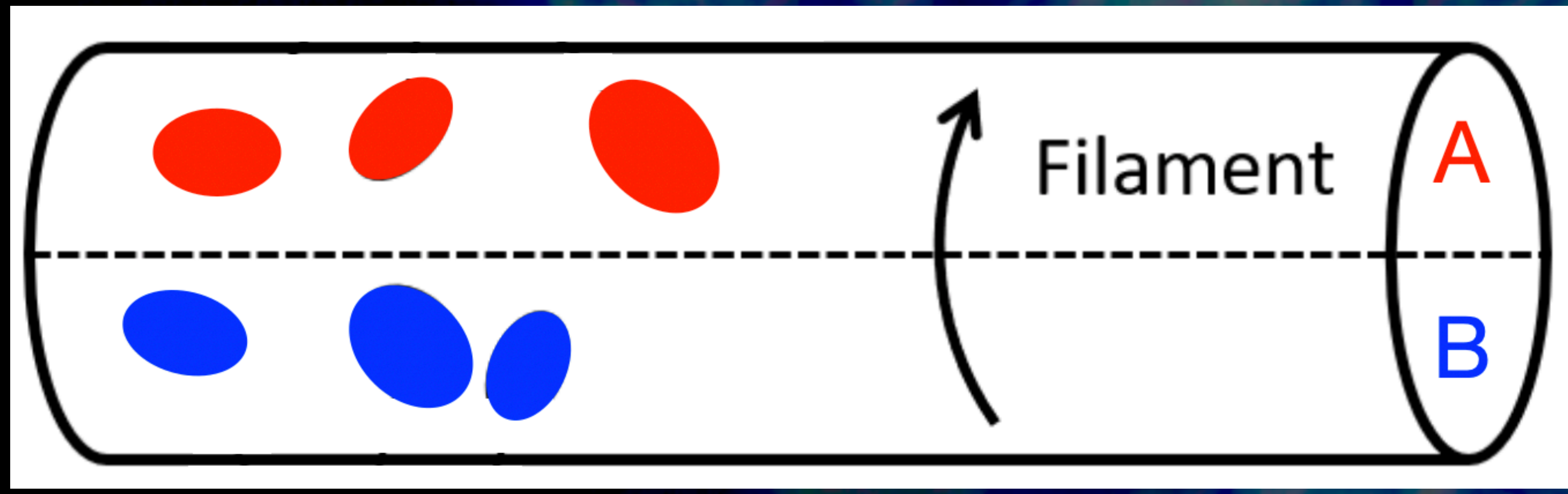
Filament spin signal

Galaxy dynamic 'temperature'

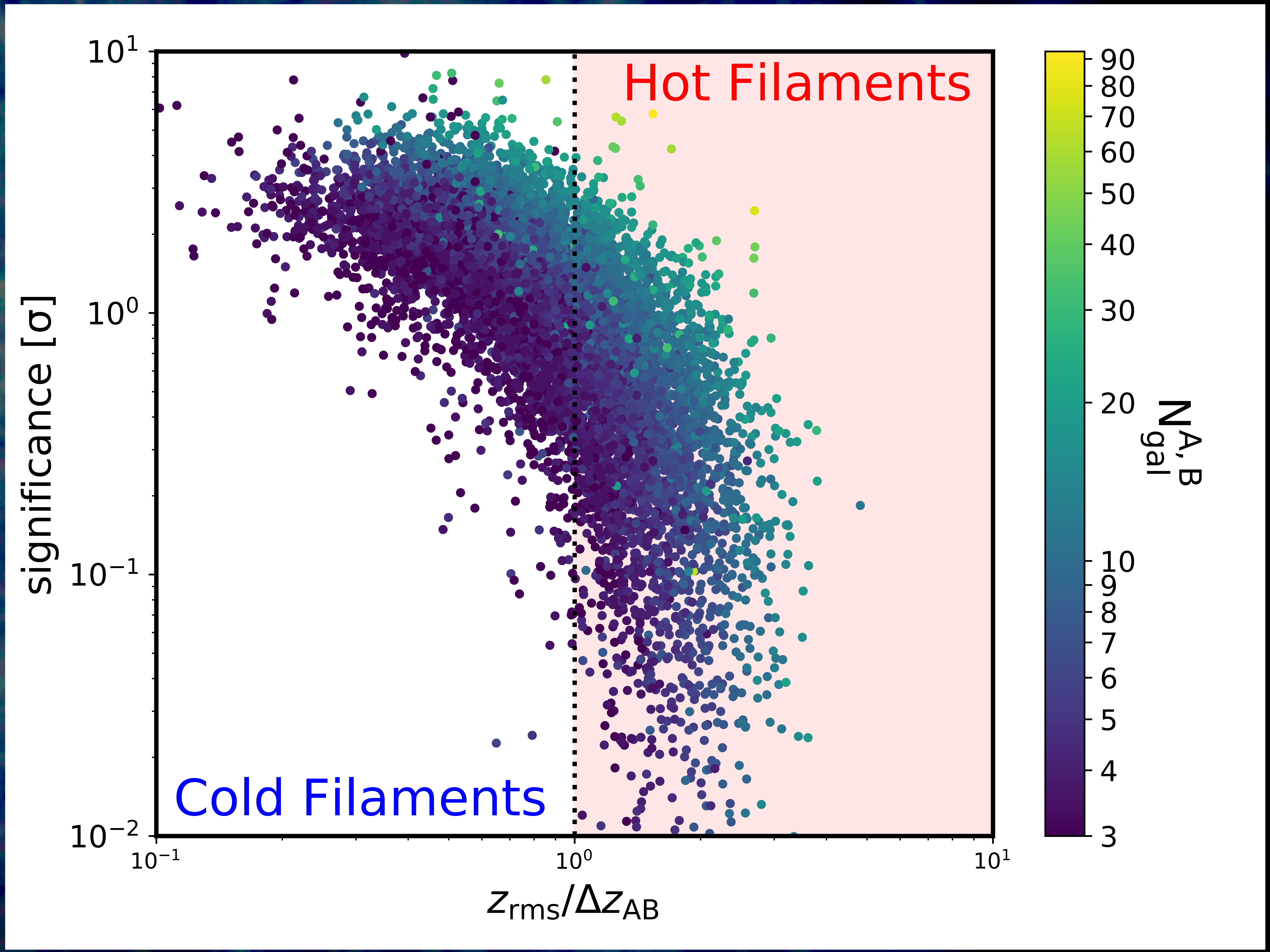


Vrms/Vc

Filament dynamic 'temperature'



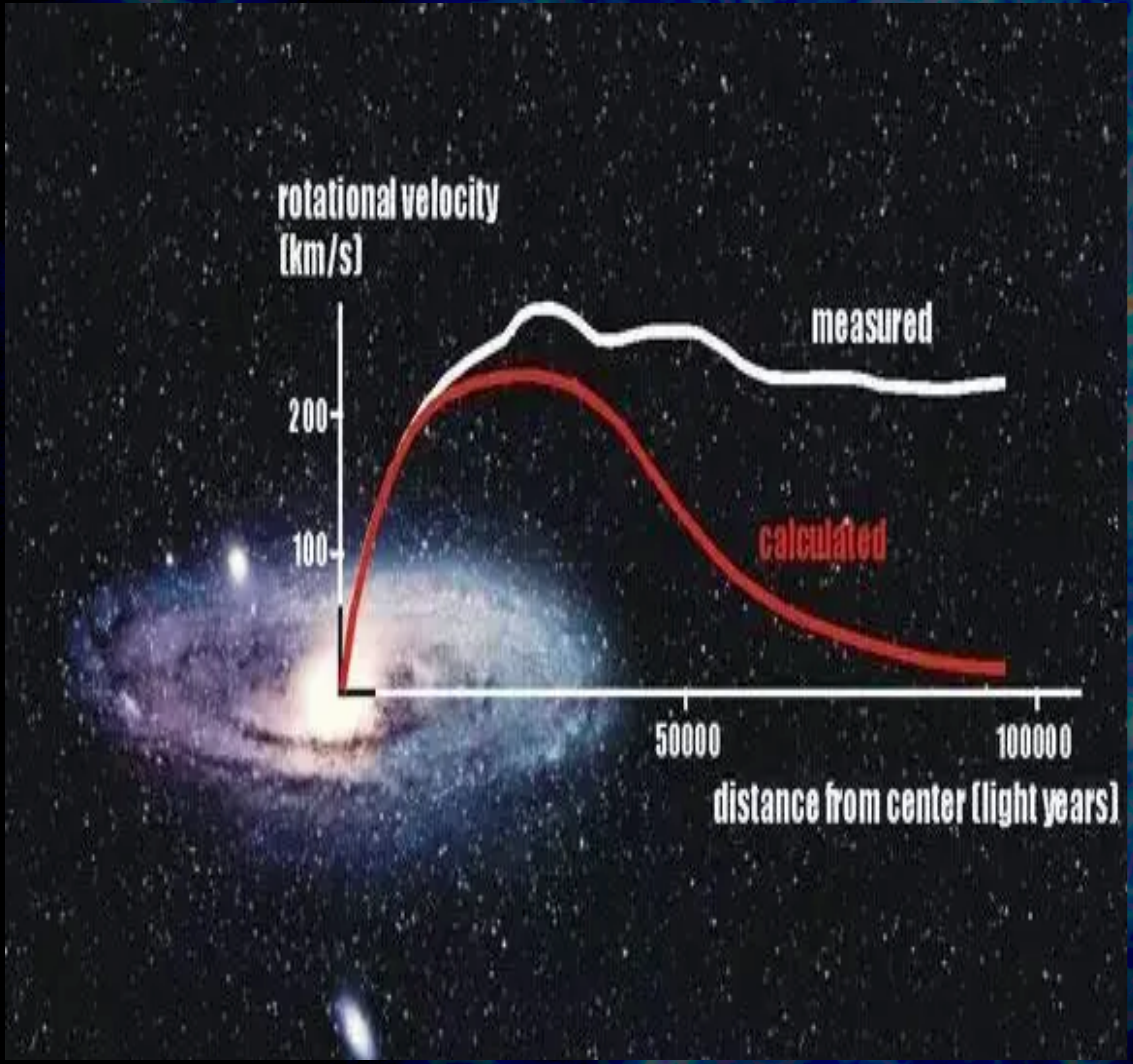
$z_{\mathrm{rms}}/\Delta z_{\mathrm{AB}}$



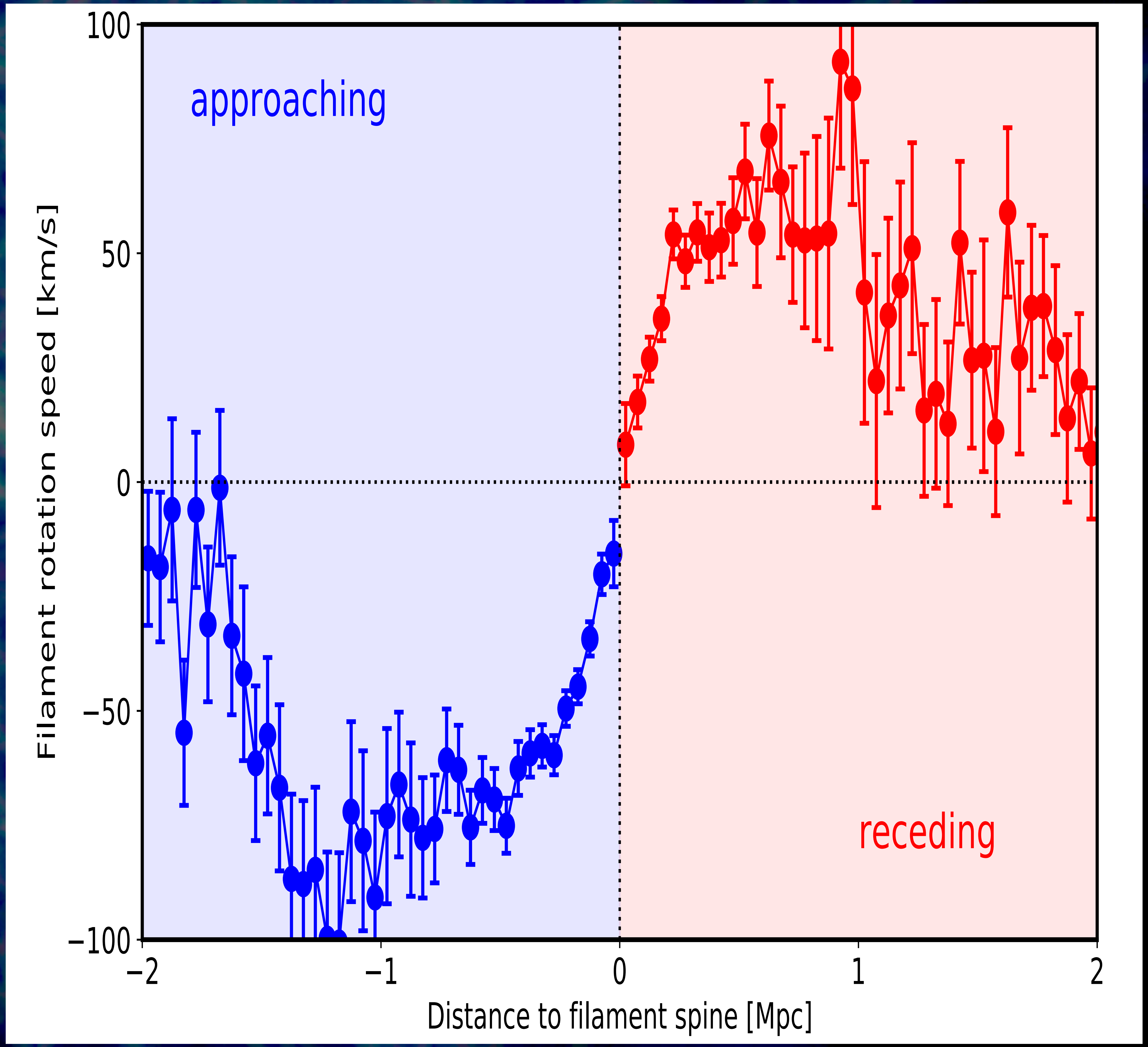
Cold → Hot

Wang et al. Nature Astronomy 2021

Filament spin signal

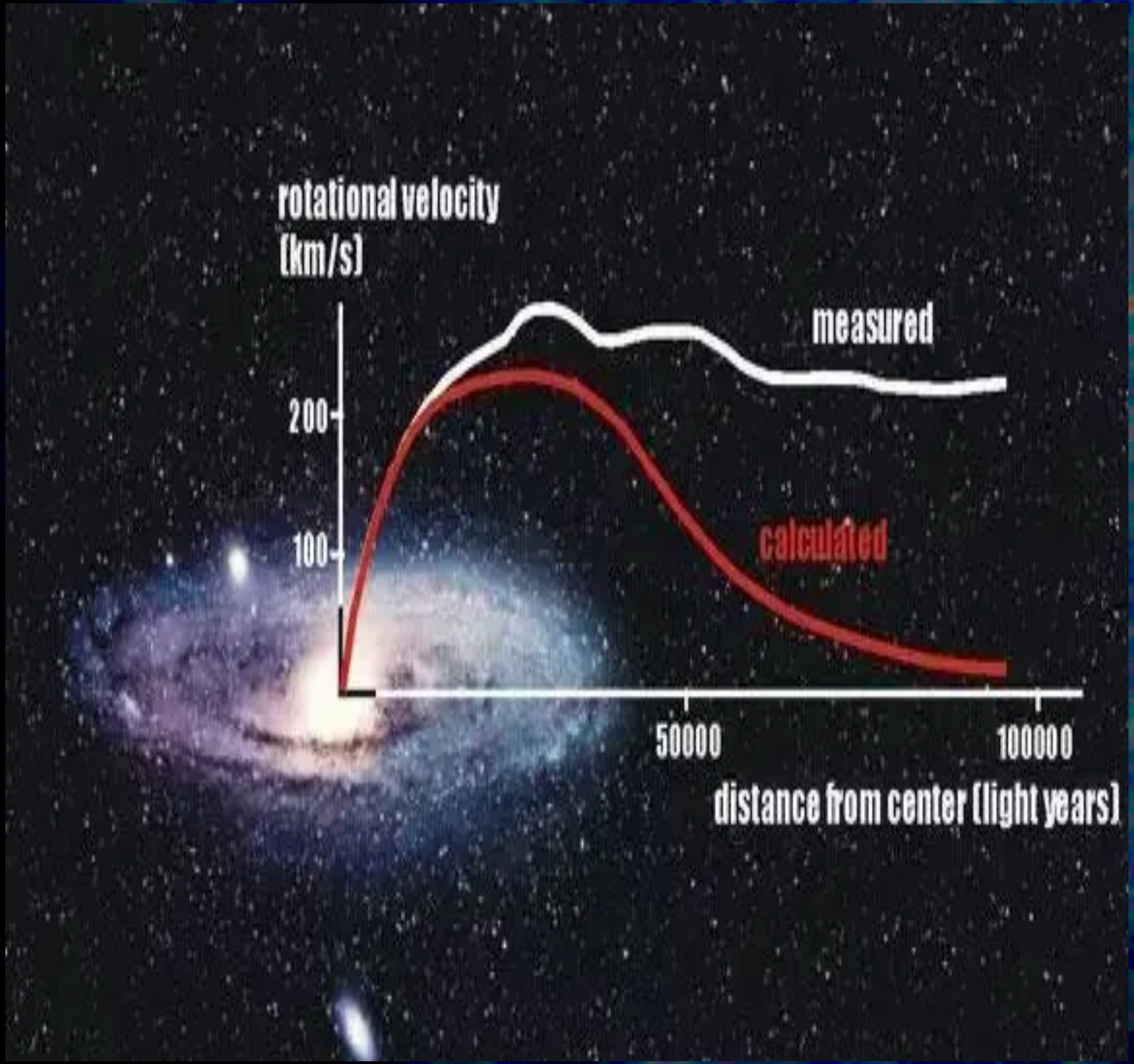


$v = c \times \Delta z_i$



Wang et al. Nature Astronomy 2021

Filament spin signal



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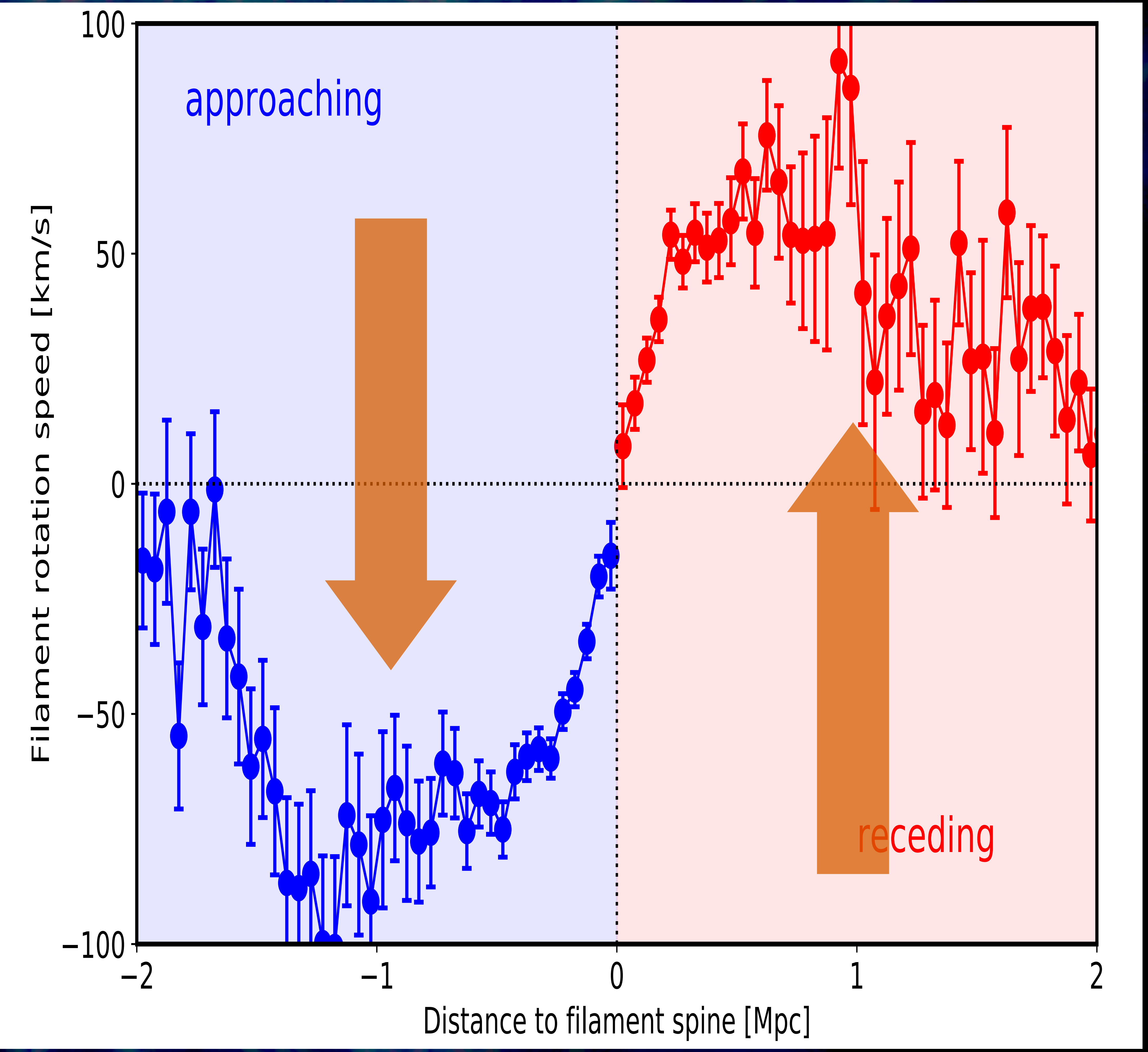
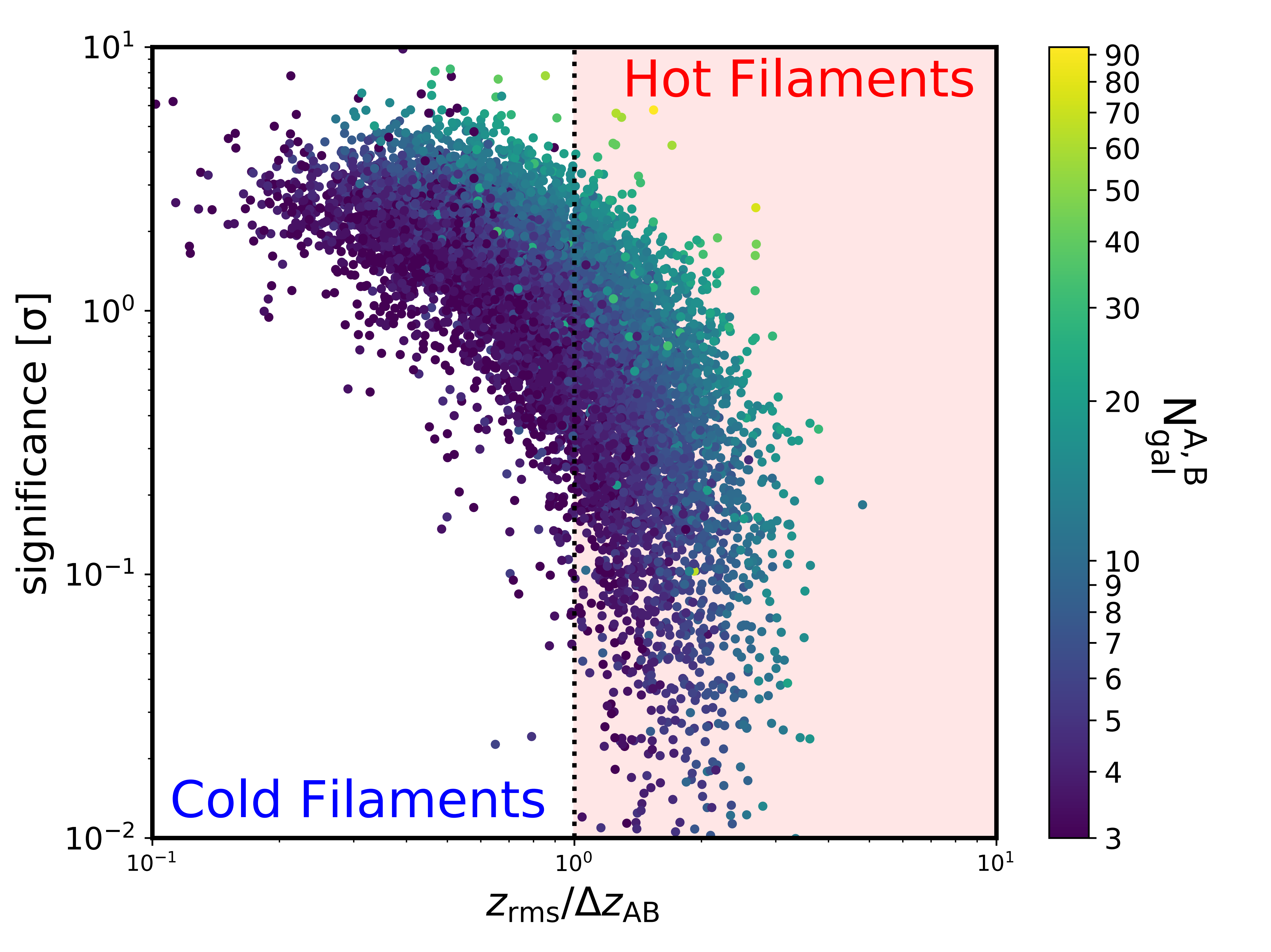


Wang et al. Nature Astronomy 2021

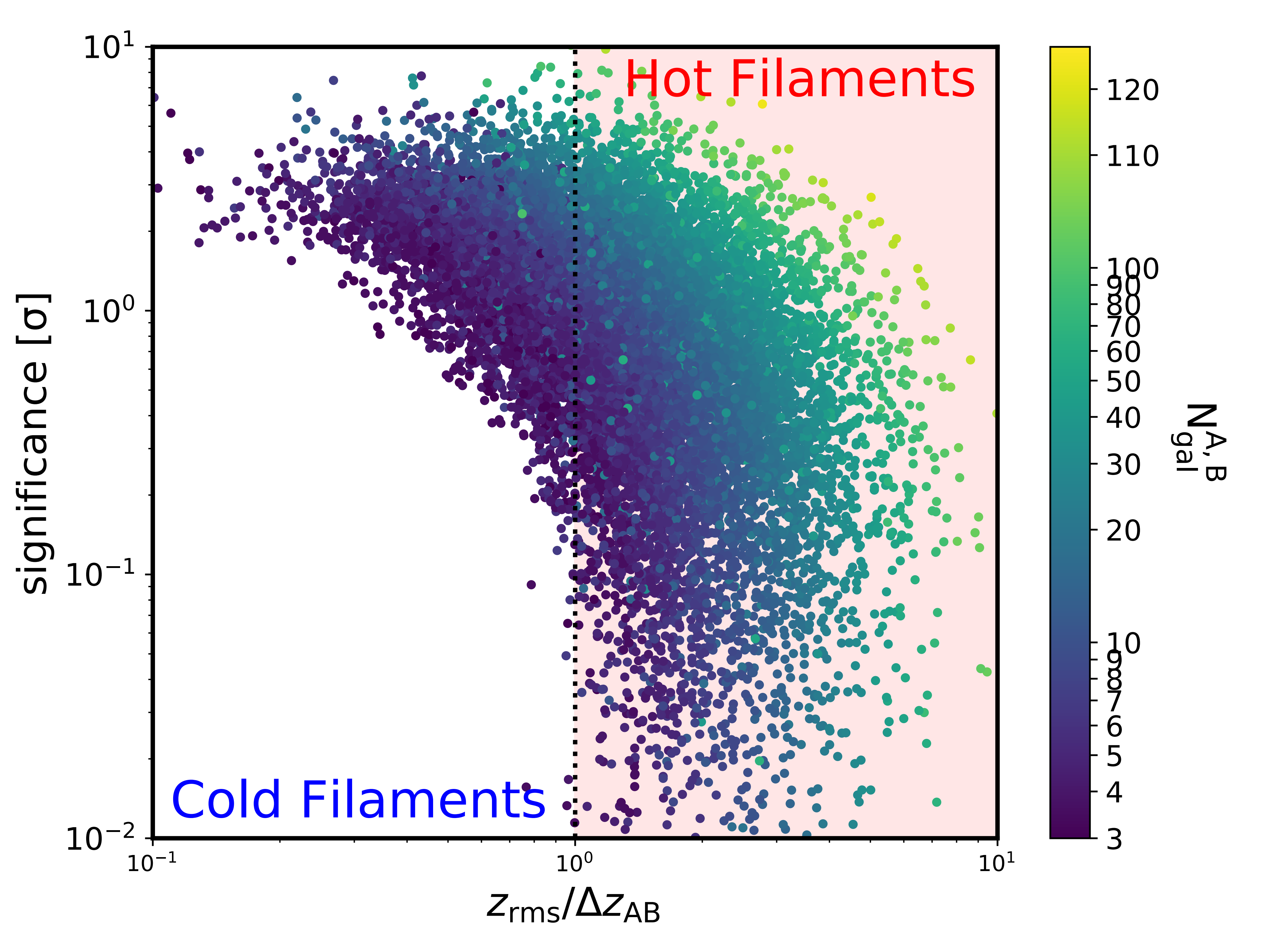
Filament rotation: obs. v.s. simu.

SDSS DR12



Wang et al. Nature Astronomy 2021

TNG300-1

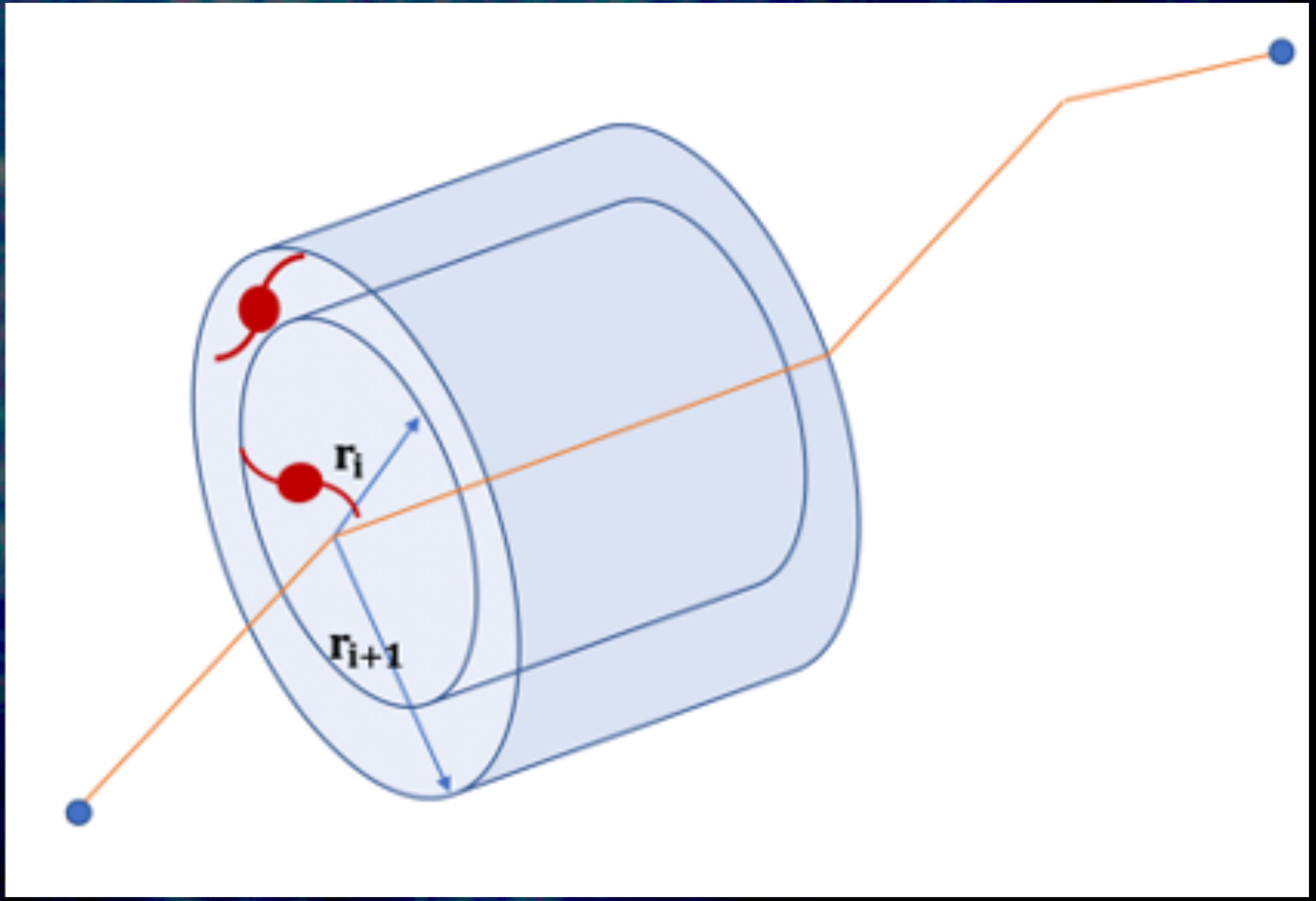


Wang et al. in prep.


Filament boundary

Filament boundary

Counting the galaxy number density in the r+dr cylindrical shell

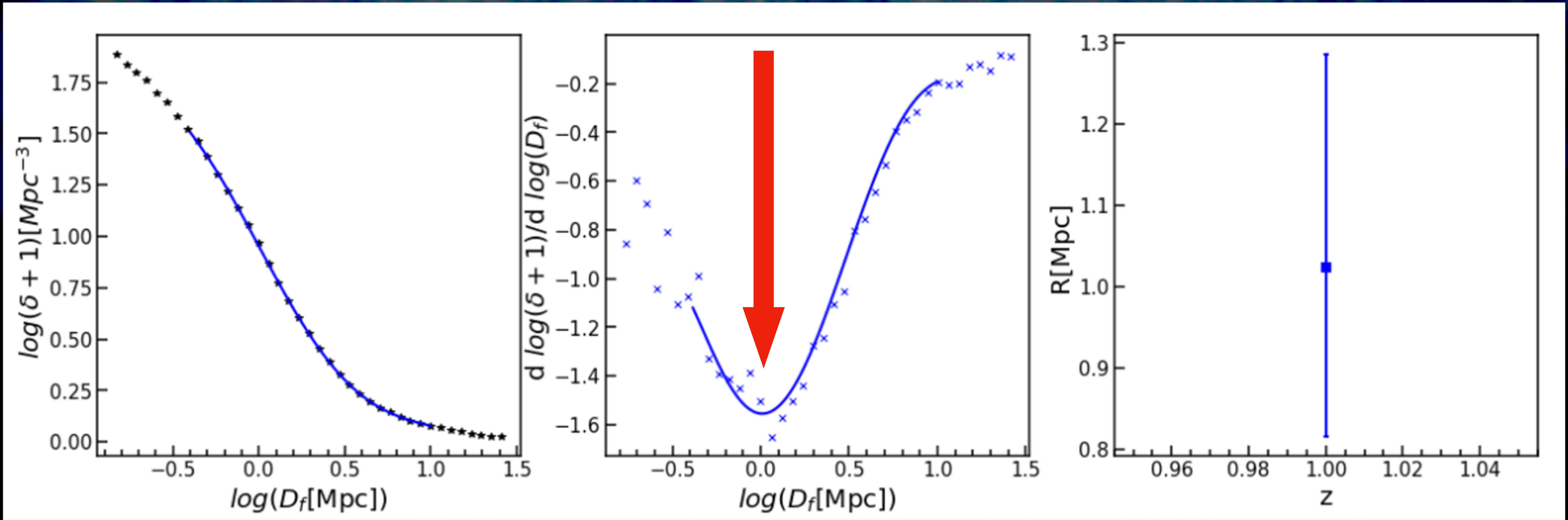


Galaxy sample: MTNG

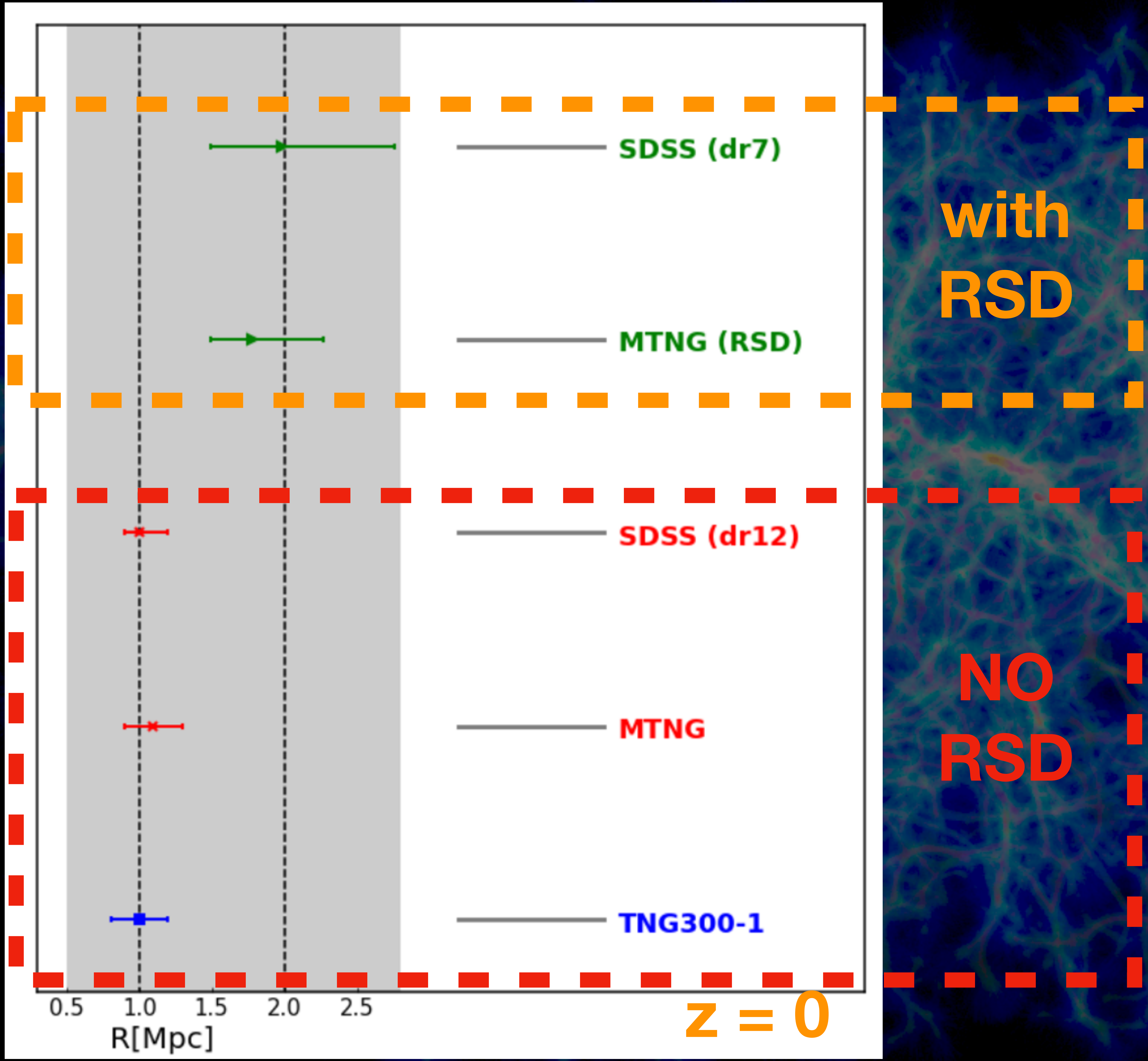
Filament: DisPerSE

Filament boundary

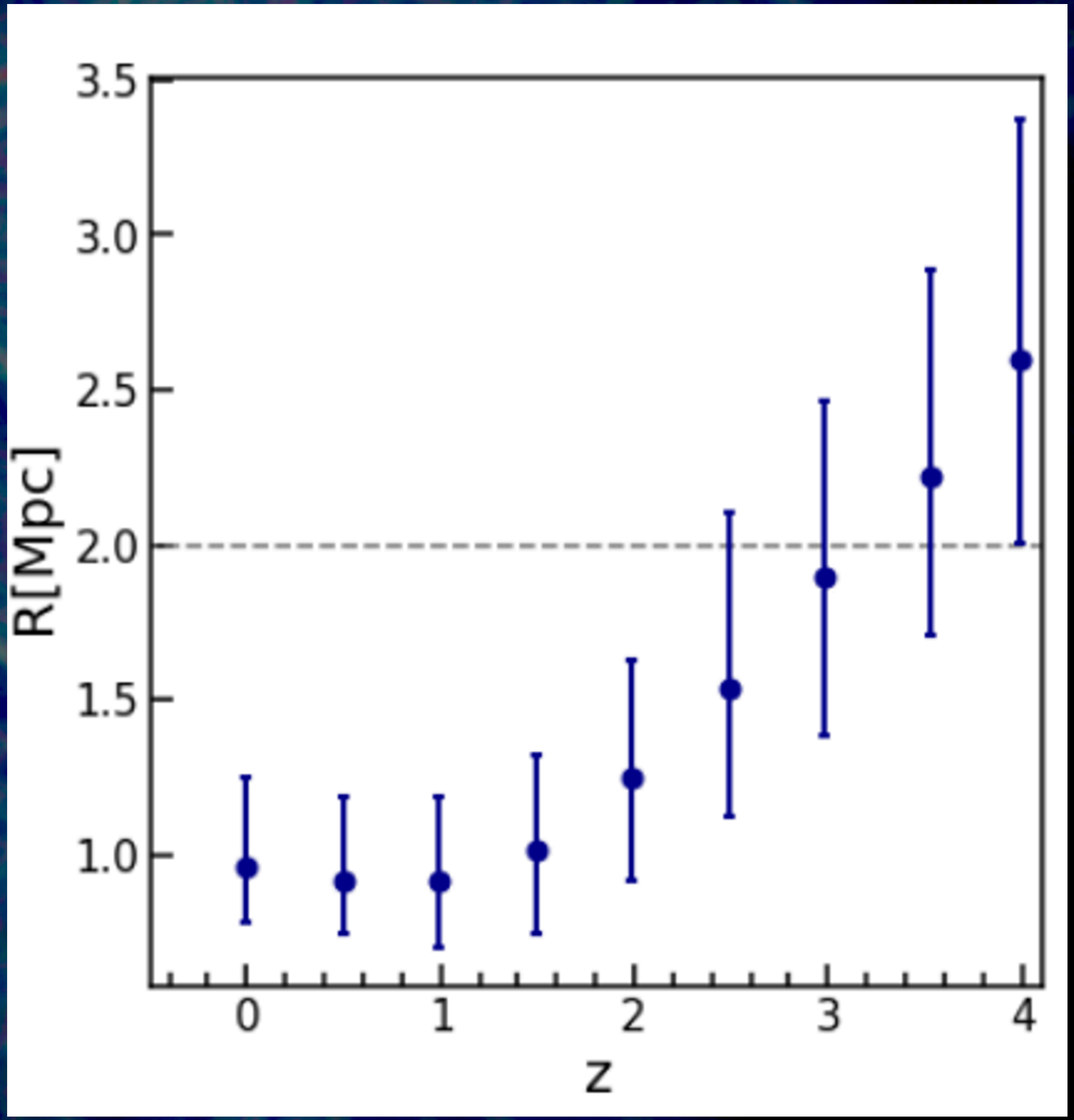
1. Matter density profile 2. Slope of matter density profile 3. Radius of filament



Wang Wei et al. in prep.

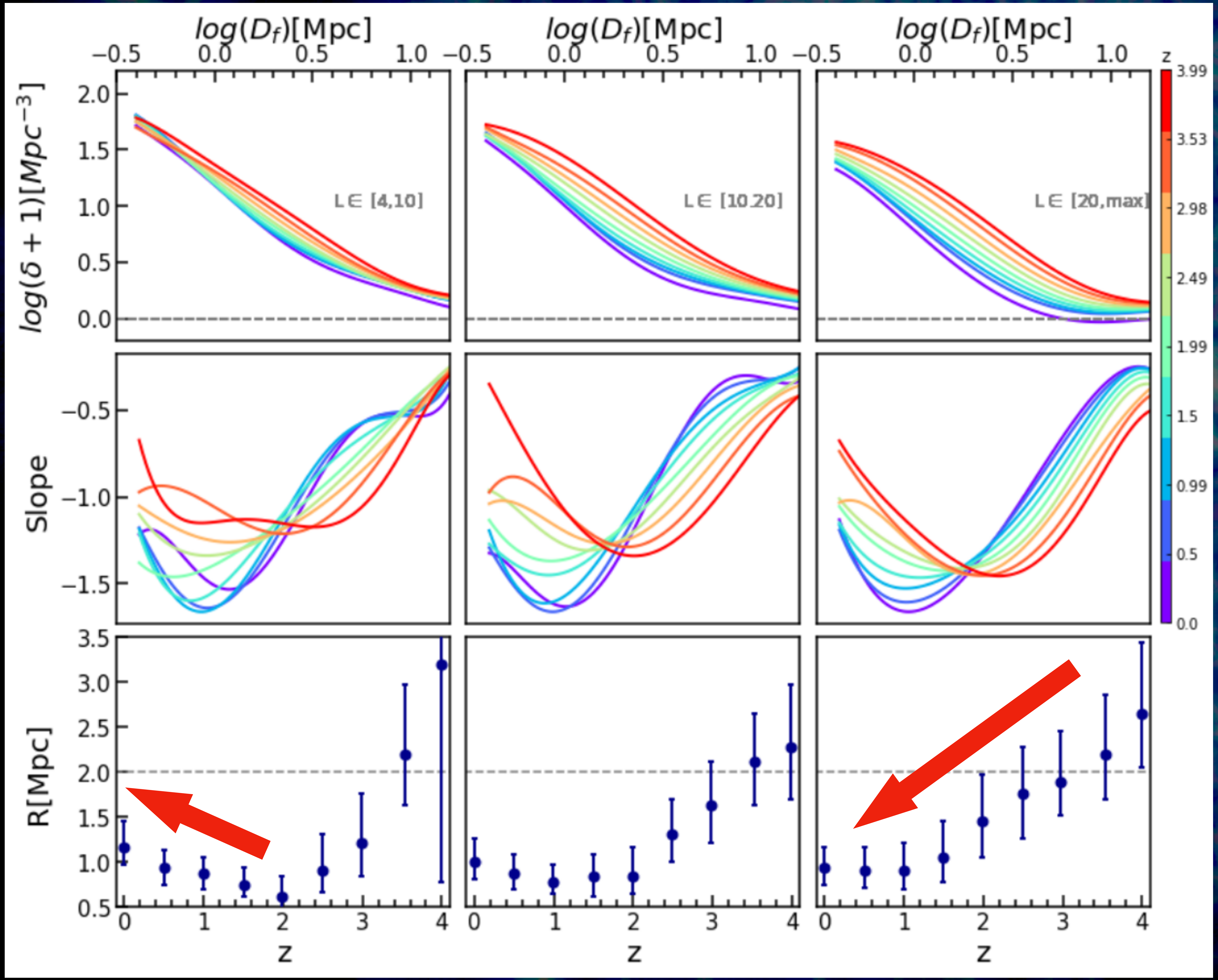


Wang Wei et al. in prep.



filament radius ~ z in MTNG

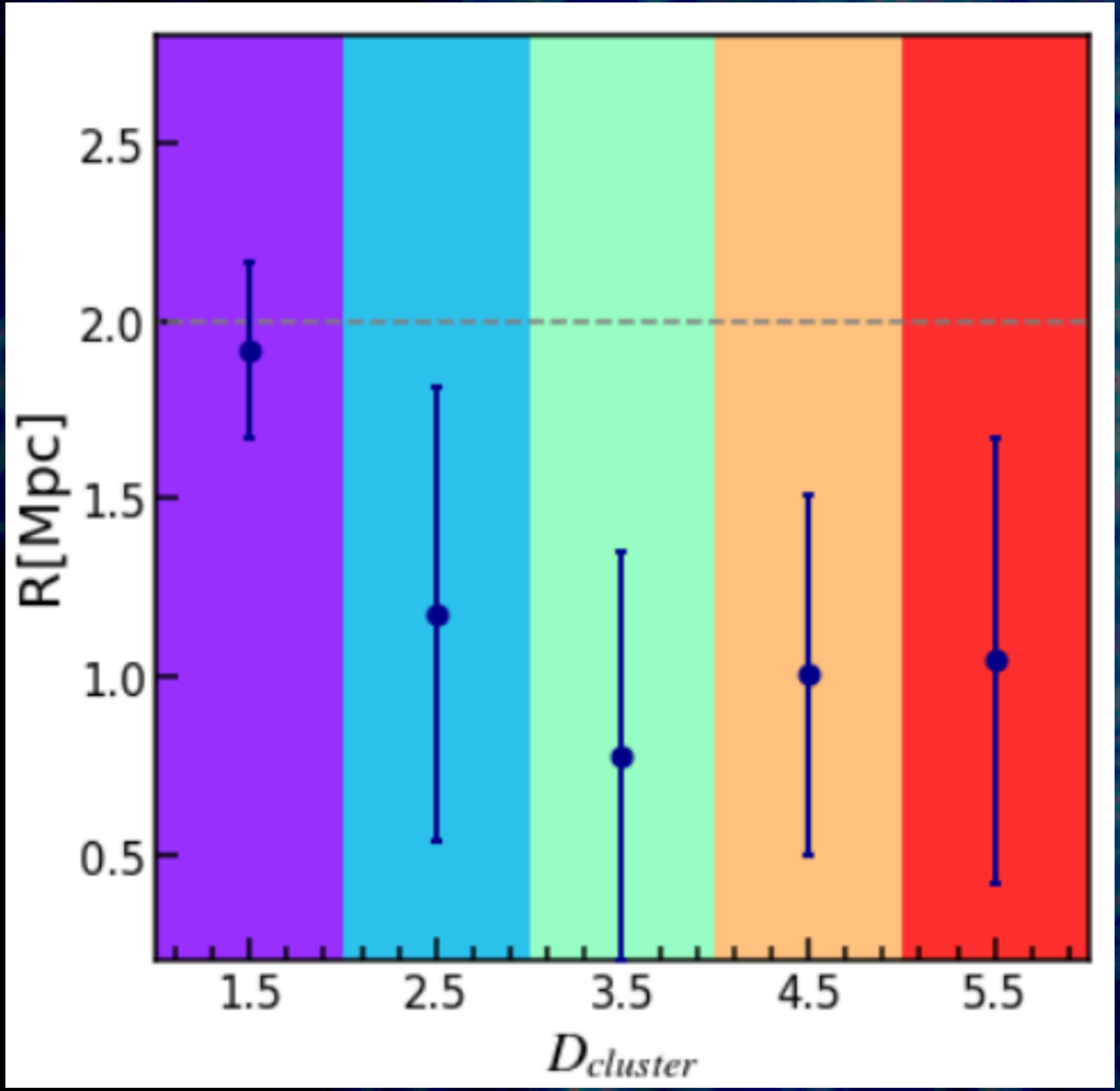
filament length from short to long



Wang Wei et al. in prep.

R (z>2) decreases from collapse
R (z<2) increases from accretion

Filament radius increases after z~2 was dominated by short filaments

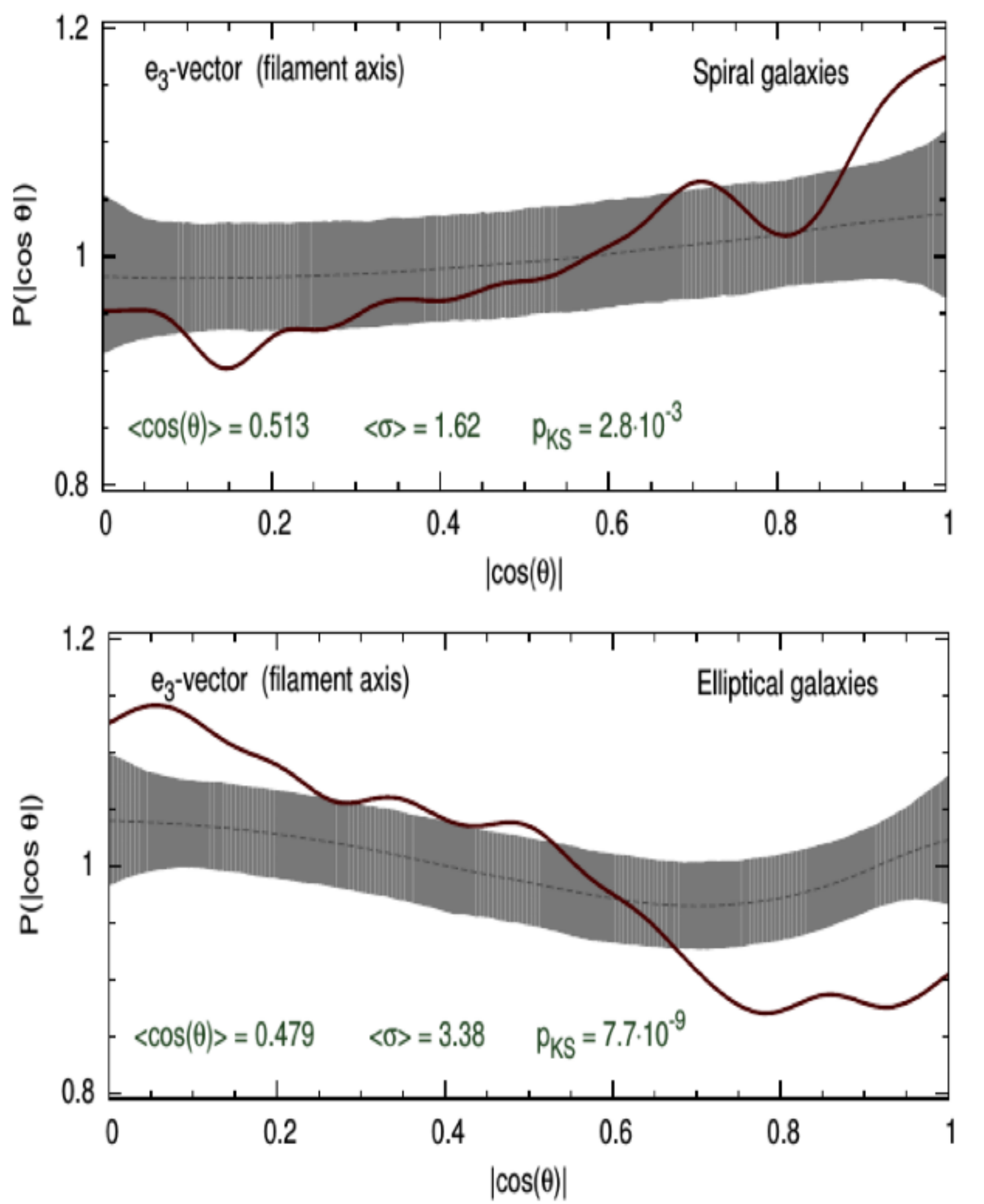


Wang Wei et al. in prep.

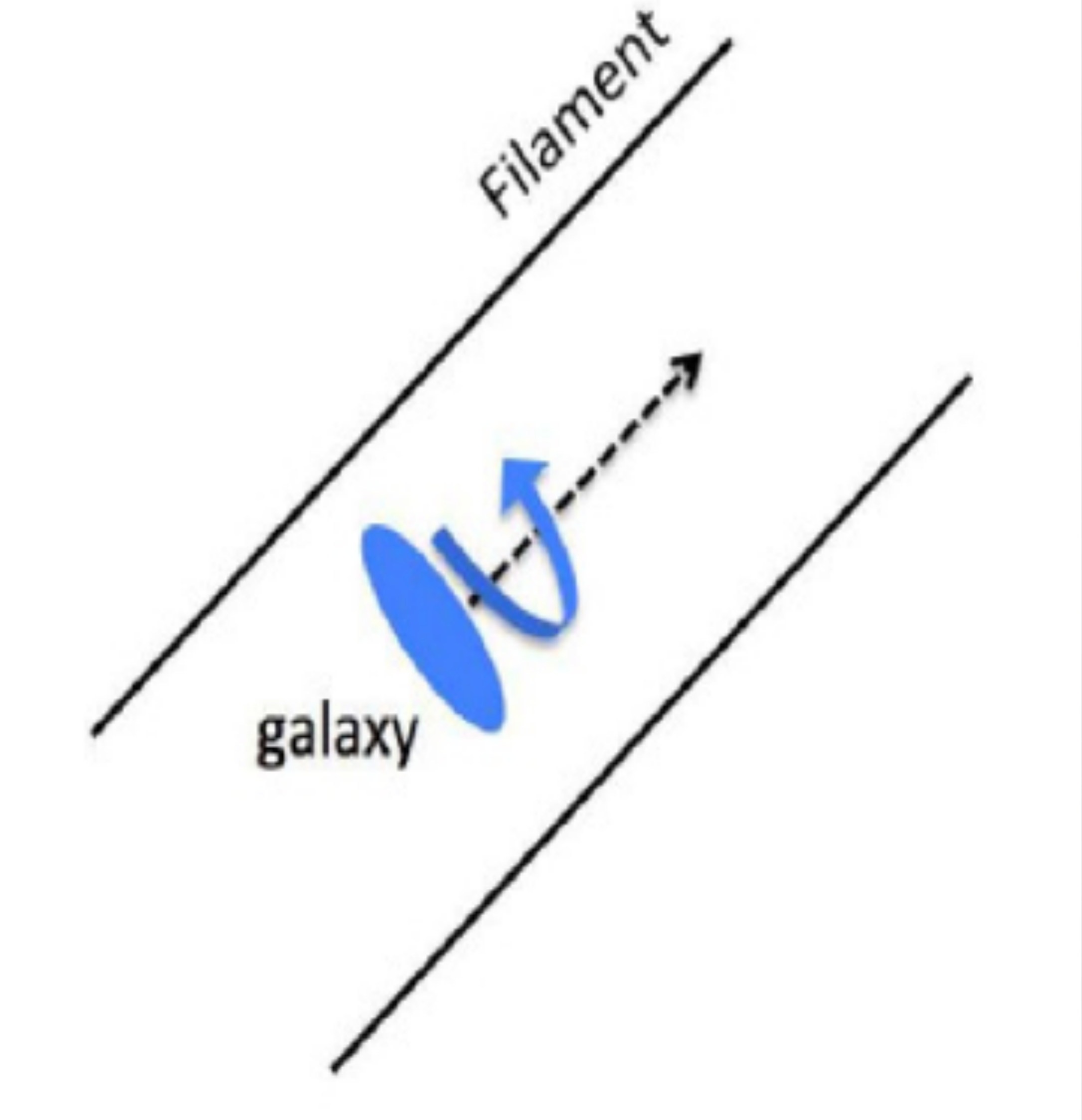
Bigger R close to cluster

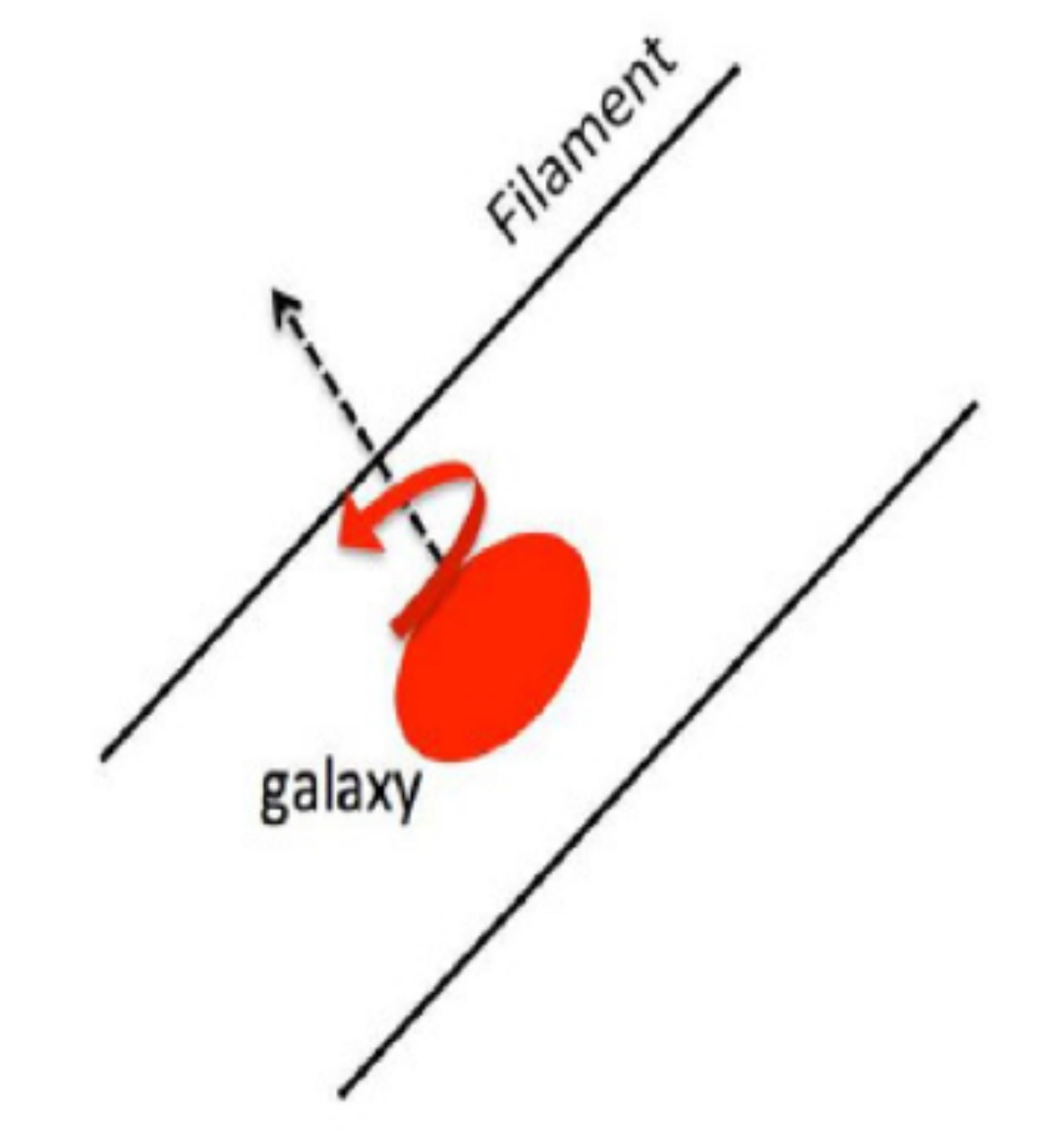
Impact on galaxy spin

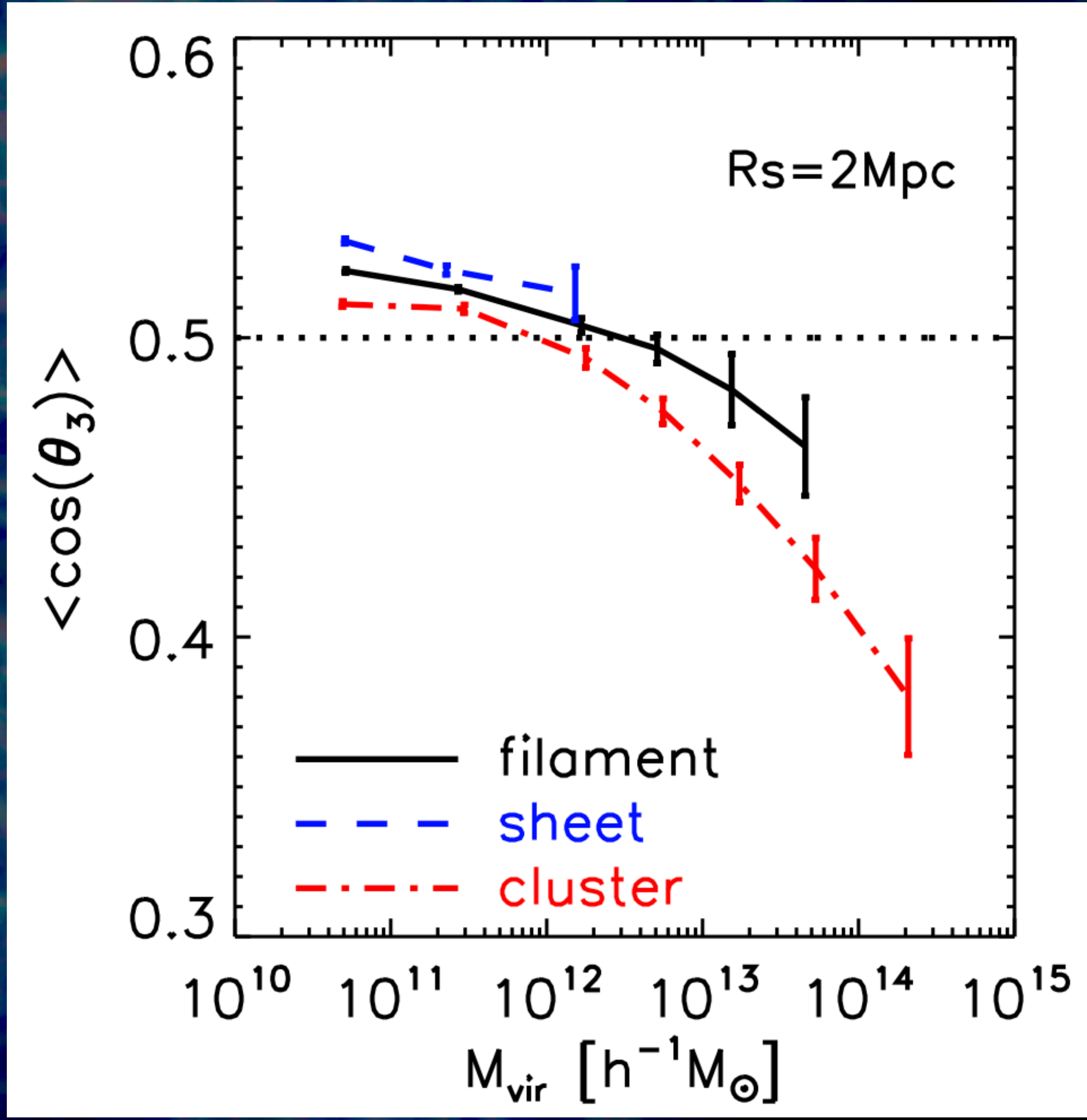
Galaxy spin correlated with filaments



Tempel & Libeskind 2014

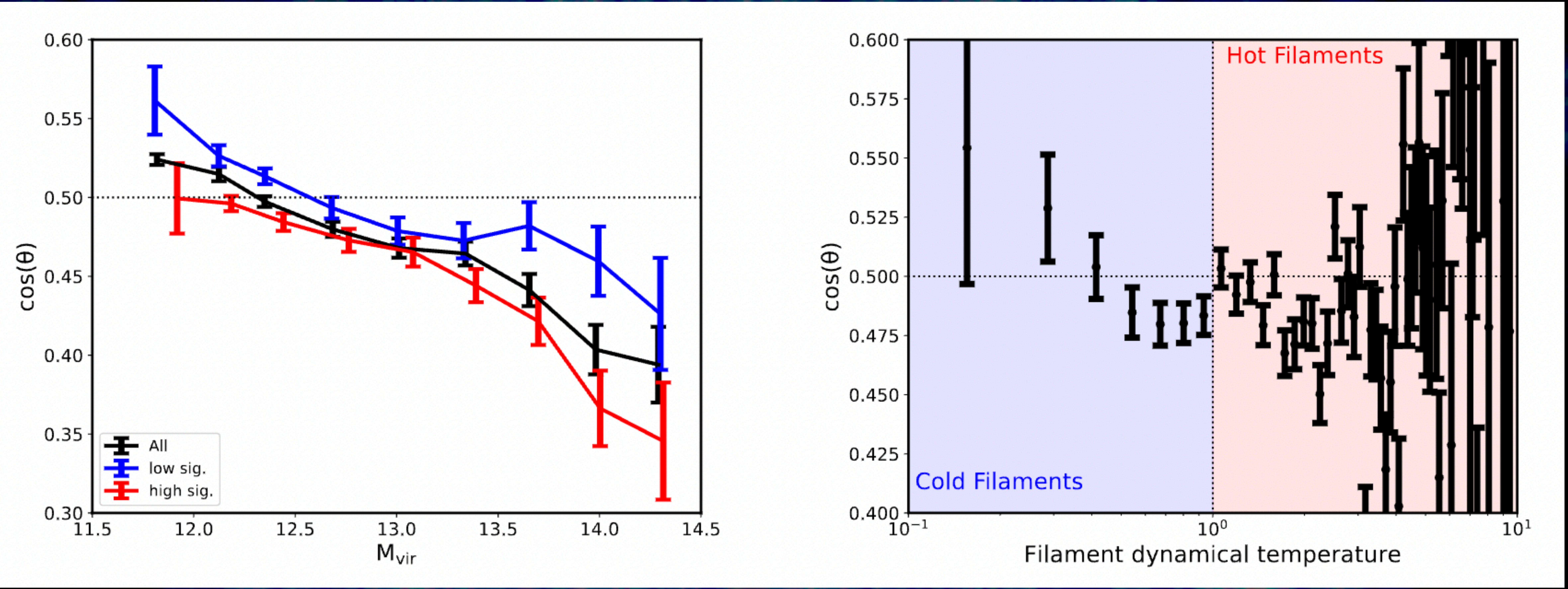






Wang & Kang 2017

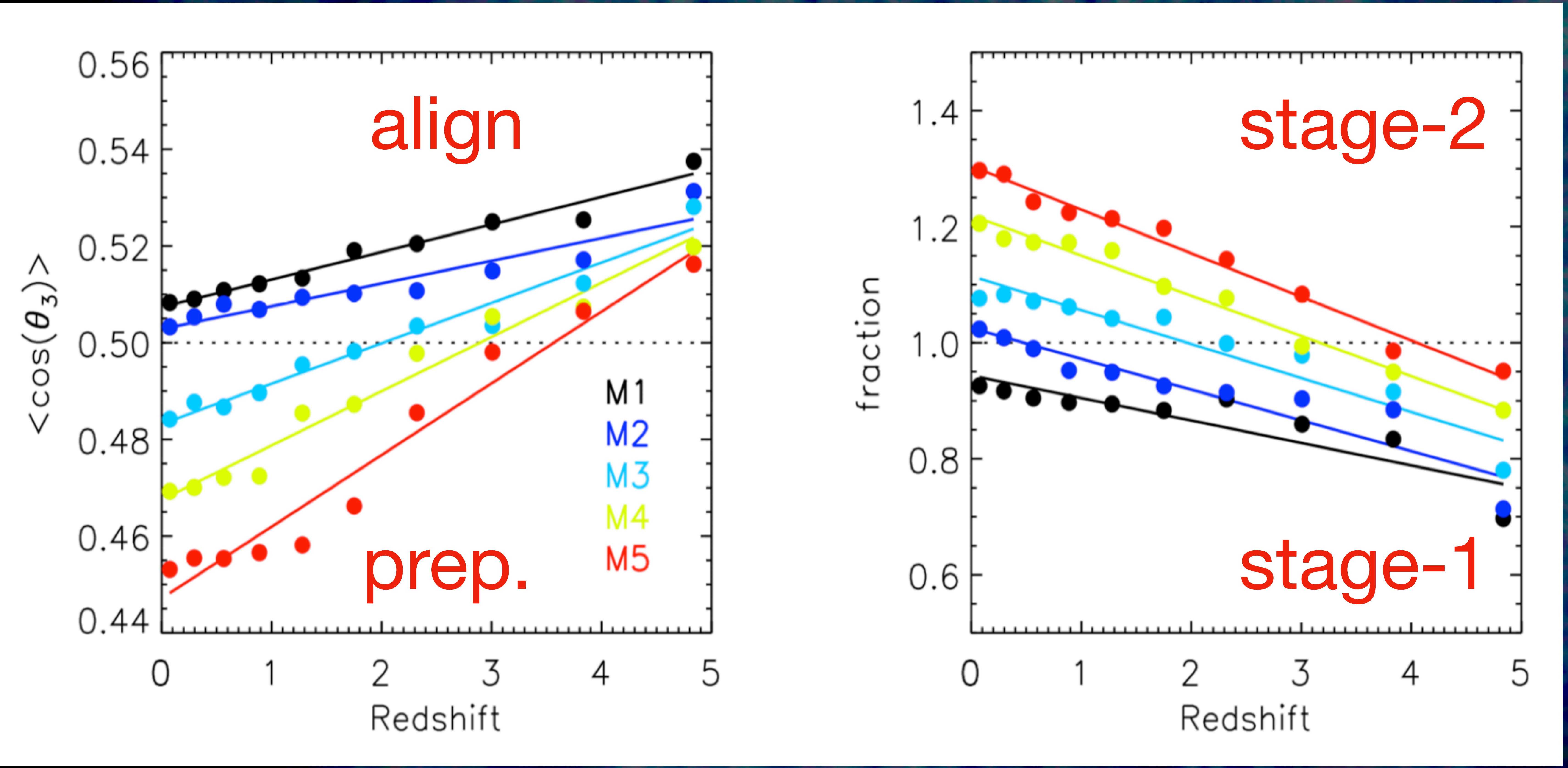
Galaxy spin-filament correlation on filament spin properties



Wang et al. in prep.

spinning, cold filaments have more impact on galaxy spin-filament correlation.

A two-stage model of halo spin-filament correlation



Wang & Kang 2018

Galaxy spin

? ? ?

Filament spin

Ongoing & future work!

Summary

1. The cosmic filament rotates itself suggests that AM can be generated on very large scales

3. We give the filament radius at ~1 Mpc/h

4. Filaments have a significant effect on galaxies' spins

Thanks! & Questions?