

# Cores, Filaments, and Bundles: Hierarchical core formation in the B213 filament in Taurus

Hacar et al 2013, A&A, 554, A55

Álvaro Hacar (IfA, Univ. Vienna)  
Mario Tafalla (OAN)  
Jens Kauffmann (Caltech)  
Attila Kovacs (UMN)

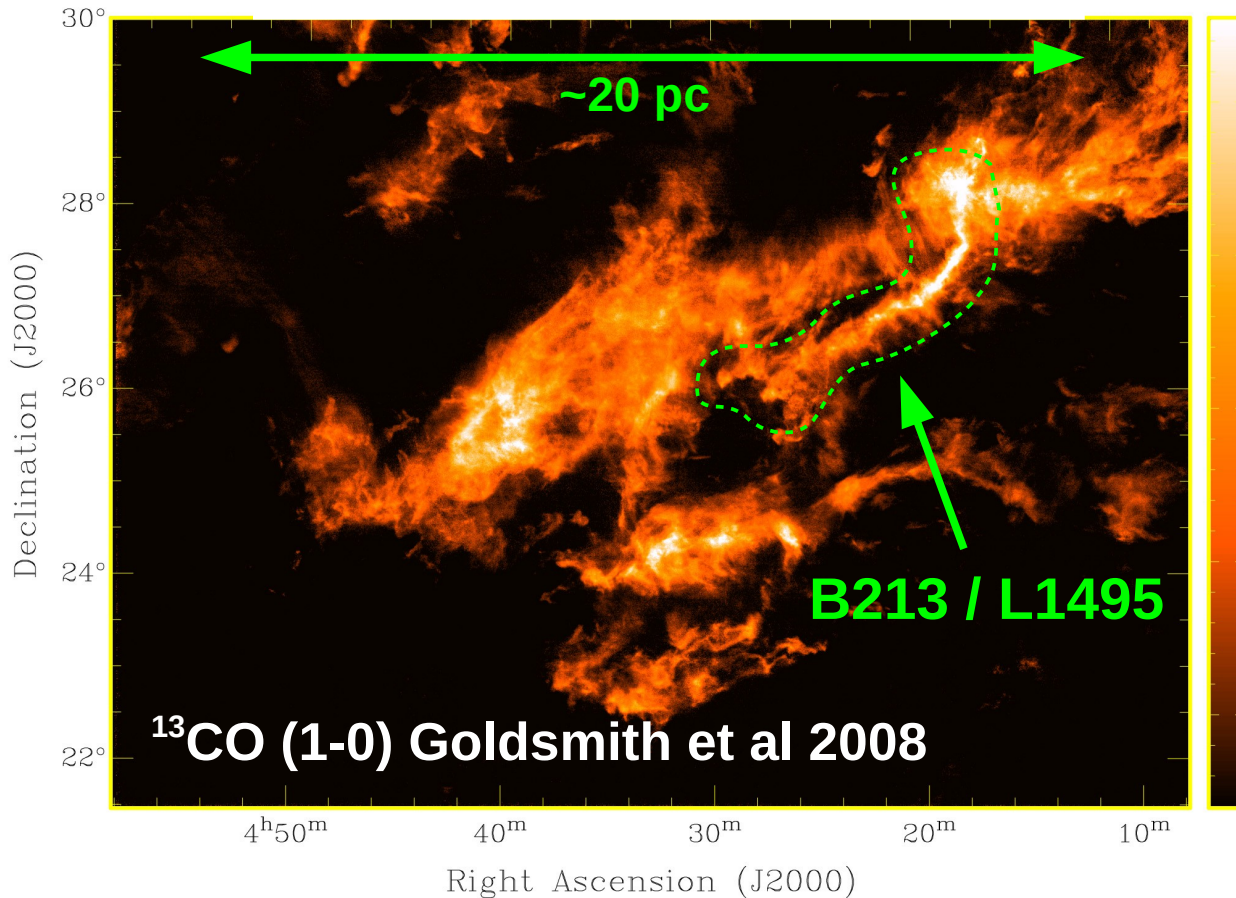


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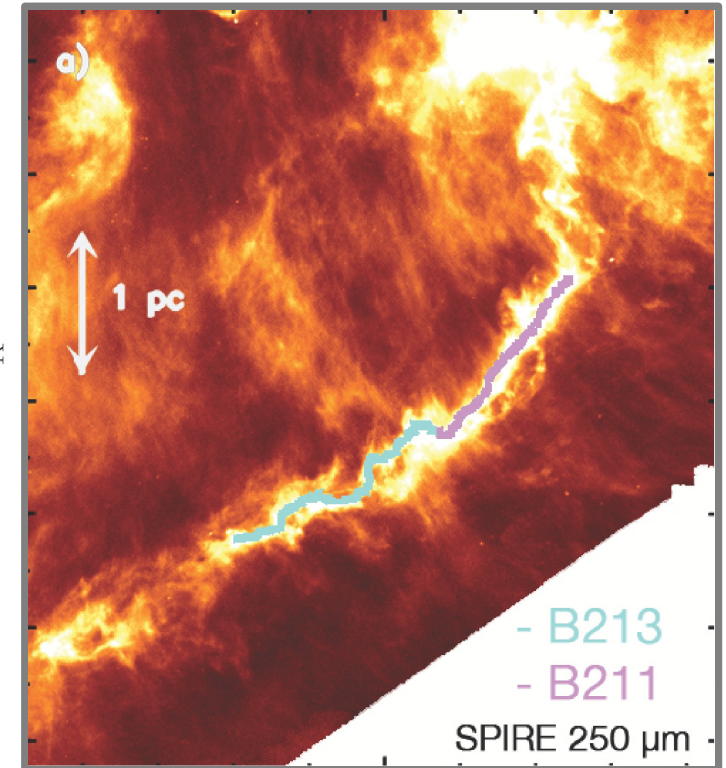


# The B213/L1495 Taurus filament

Taurus Molecular Cloud



Herschel-SPIRE

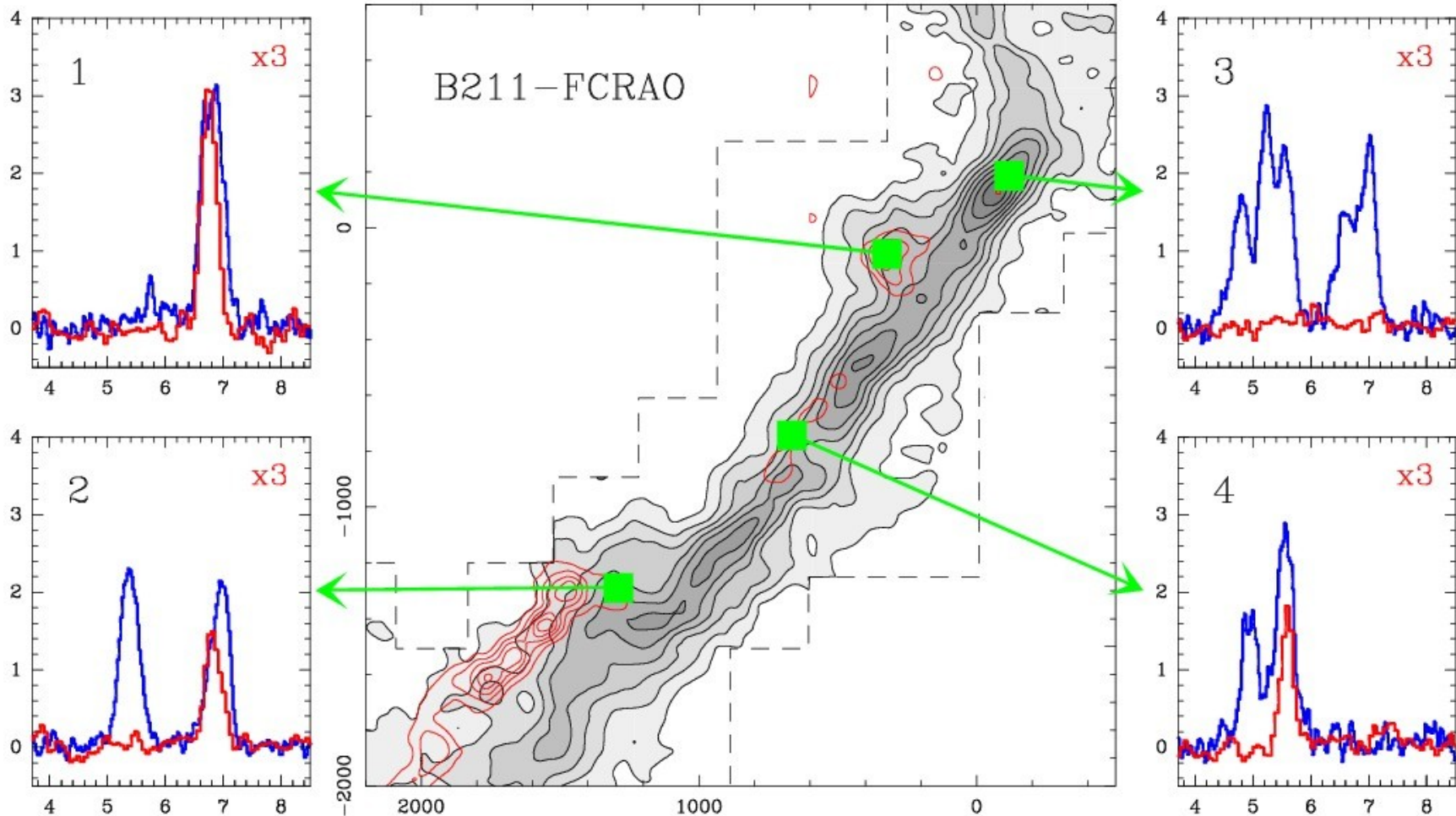


Palmeirim et al. 2013,  
P. André's talk

- **B213/L1495**: One of the most prominent filaments in nearby clouds
- Mass  $> 700 M_{\odot}$  & L  $\sim 10$  pc,  $\sim 40$  YSOs &  $\sim 20$  dense cores
- Study of the gas kinematics using large-scale mm-line observations:  
 $\text{C}^{18}\text{O} (1-0)$ ,  $\text{C}^{17}\text{O} (1-0)$ ,  $\text{SO} (3_2-2_1)$  &  $\text{N}_2\text{H}^+ (1-0) \rightarrow 23.000$  spectra each

# Complex kinematic structure in B213 / L1495

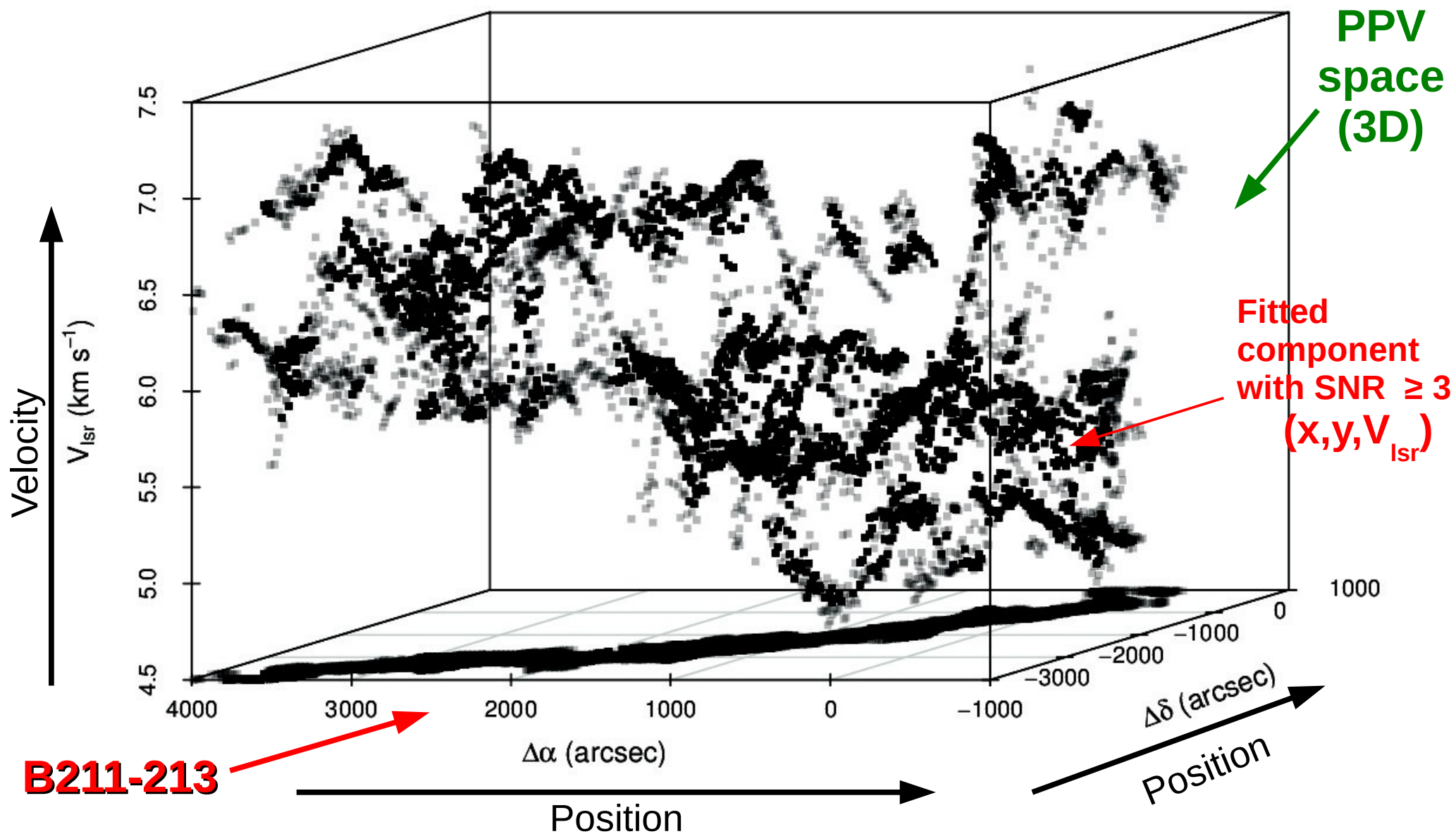
$\text{N}_2\text{H}^+$  (red) +  $\text{C}^{18}\text{O}$  (blue)



A&A 2013 Highlights

- Complex kinematic structure
- High multiplicity in the l.o.s. → up to 5 components !
- Also characteristic of other filaments (e.g. IRDC, see Hensaw+)
- Standard analysis techniques (e.g. channel maps) not valid

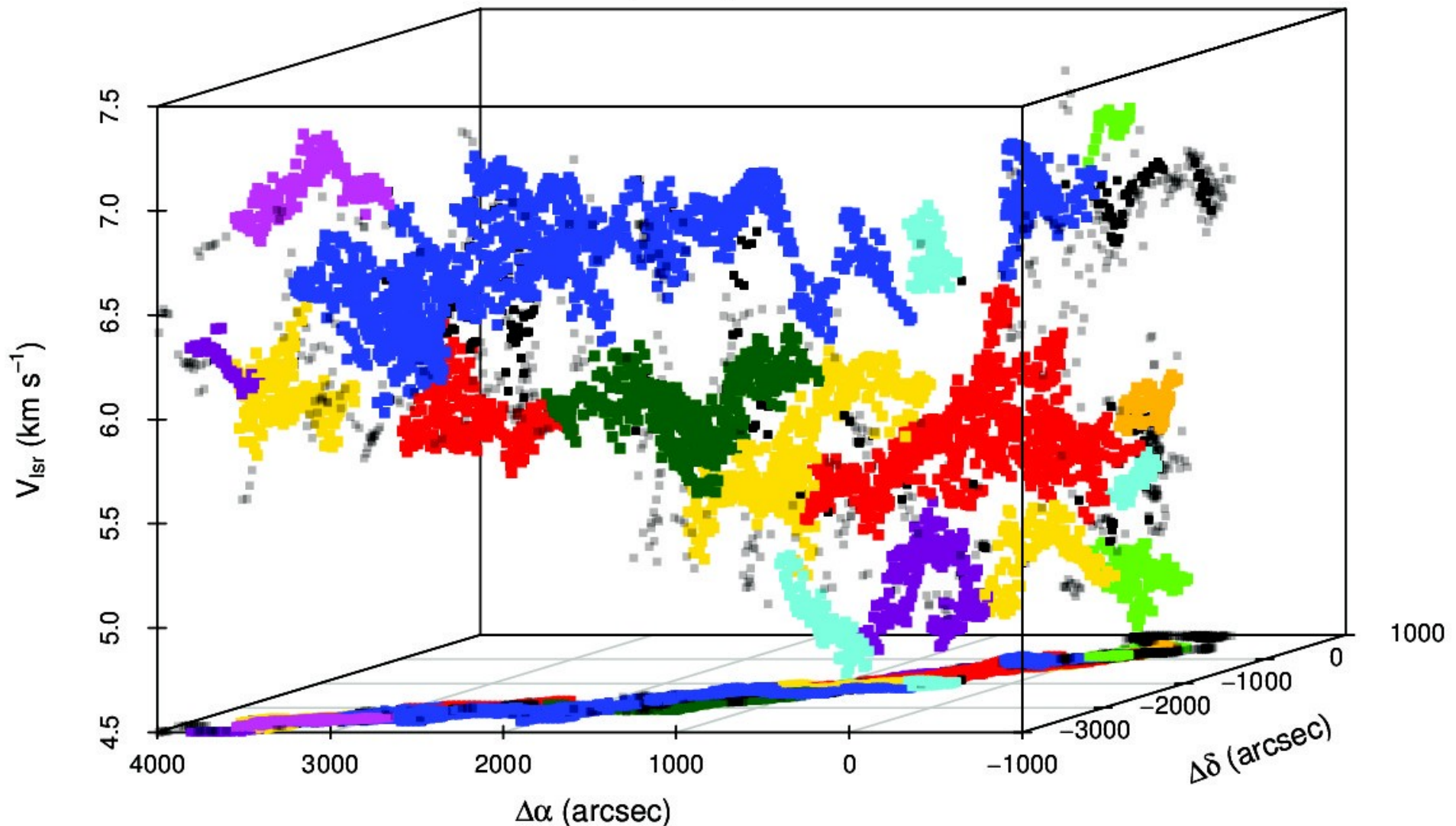
# B213/L1495 data in PPV space



- Data:  $\sim 12,000$  individual fits ( $\text{C}^{18}\text{O} + \text{N}_2\text{H}^+$ ) with  $\text{SNR} \geq 3$

# FIVE: Results

## c) Step 3: Association



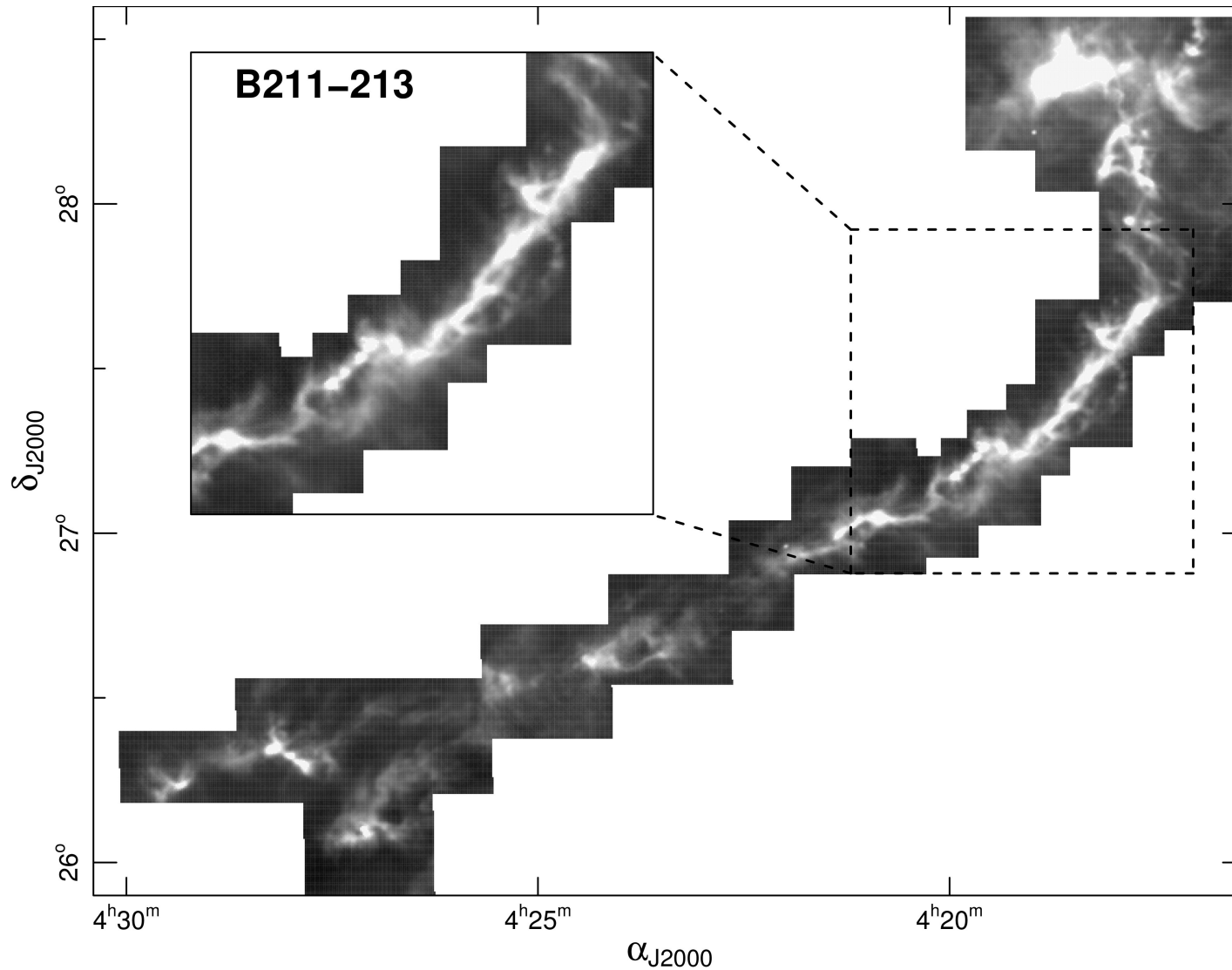
- Friends-In-Velocity (FIVE): new algorithm
- Results : **35 velocity-coherent structures in B213 / L1495 !!**

# Velocity-coherent structures in B213 / L1495 (I)

## Statistical properties of the 35 velocity-coherent structures:

- Aspect Ratio  $> 3-4 \rightarrow$  Filamentary
- $M_{\text{lin}} \sim 15 M_{\odot} \text{ pc}^{-1} \rightarrow$  close to equilibrium
- $L \sim 0.6 \text{ pc}$
- $\sigma_{\text{NT}} \ \& \ \sigma(V_{\text{lsr}}) \sim C_S \rightarrow \sim$  (tran-)sonic
- Similar to those filaments found in L1517 ( $M_{\text{lin}} \sim 16 M_{\odot} \text{ pc}^{-1}$ ,  $L \sim 0.5 \text{ pc}$ ,  $\sigma_{\text{NT}} \ \& \ \sigma(V_{\text{lsr}}) < C_S$ )  
 $\Rightarrow$  Velocity-coherent filaments (= fibers)  
(see also Hacar & Tafalla 2011)

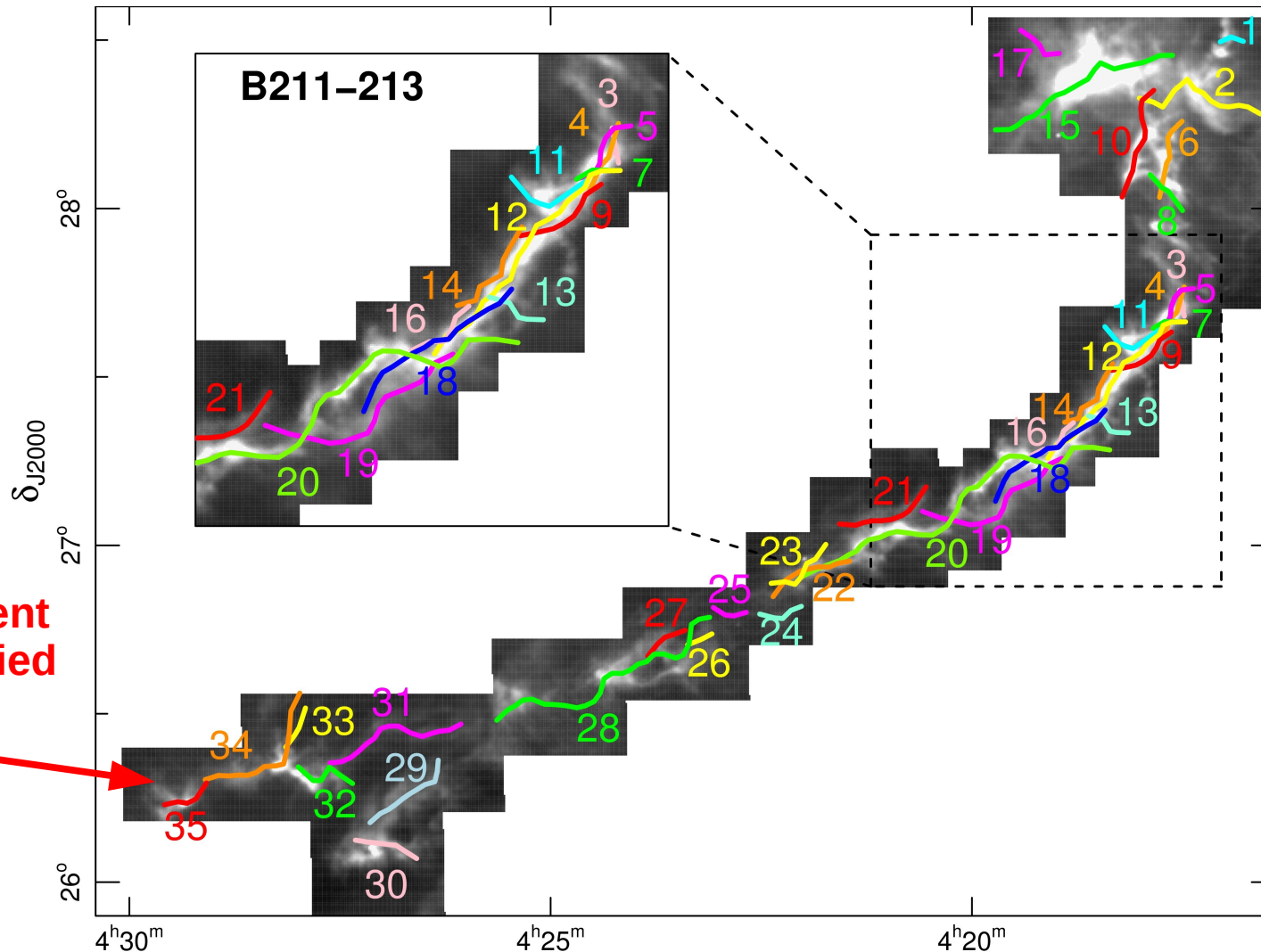
# Velocity-coherent structures in B213 / L1495 (II)



Background image 250 $\mu\text{m}$  Herschel-SPIRE  
Gould Belt project. PI: P. André  
(Palmeirim et al 2013)

- **FIVE** = Systematic analysis of the gas velocity structure within this region ( $> 12.000$  individual fits)

# Velocity-coherent structures in B213 / L1495 (II)



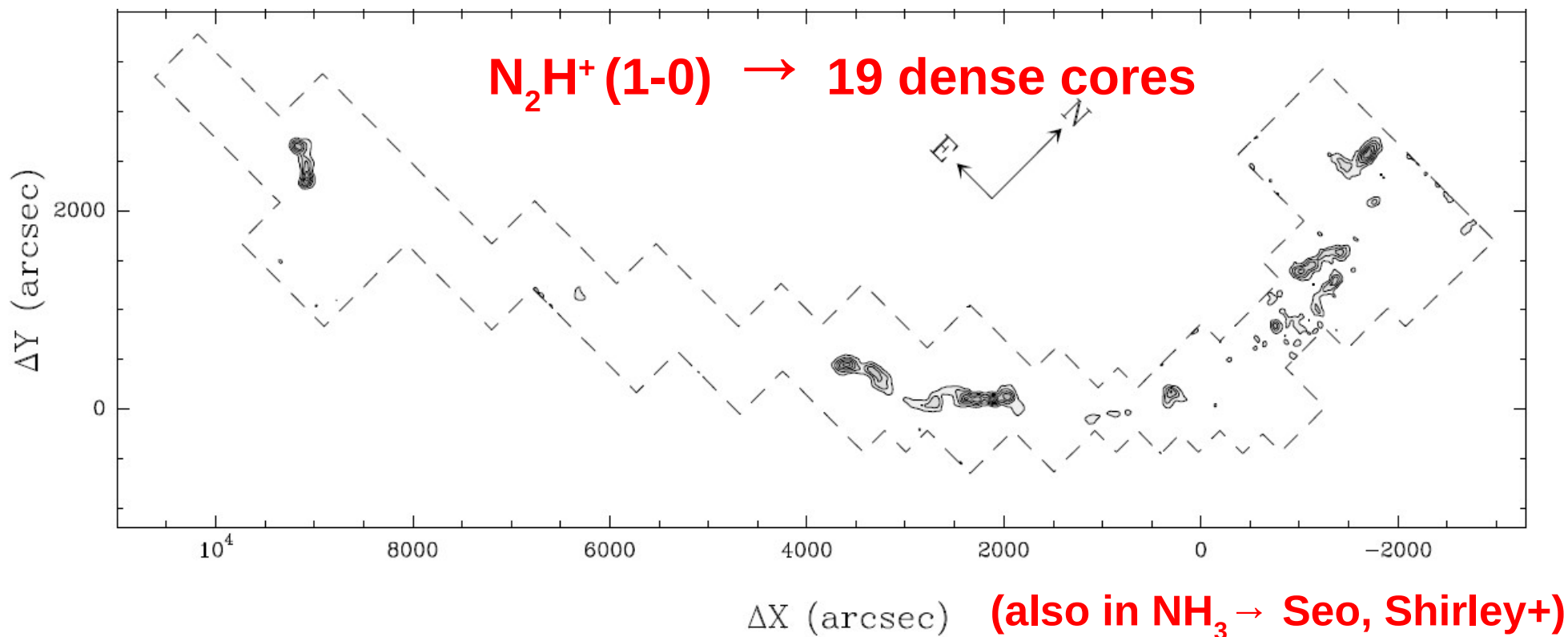
Velocity-coherent  
filaments identified  
by FIVE

Background image 250 $\mu$ m Herschel-SPIRE  
Gould Belt project. PI: P. André  
(Palmeirim et al 2013)

- B213 = 35 velocity-coherent filaments (fibers) forming a bundle
- All the gas at  $n(\text{H}_2) \sim 10^3\text{-}10^4 \text{ cm}^{-3}$  is highly structured before the formation of the cores

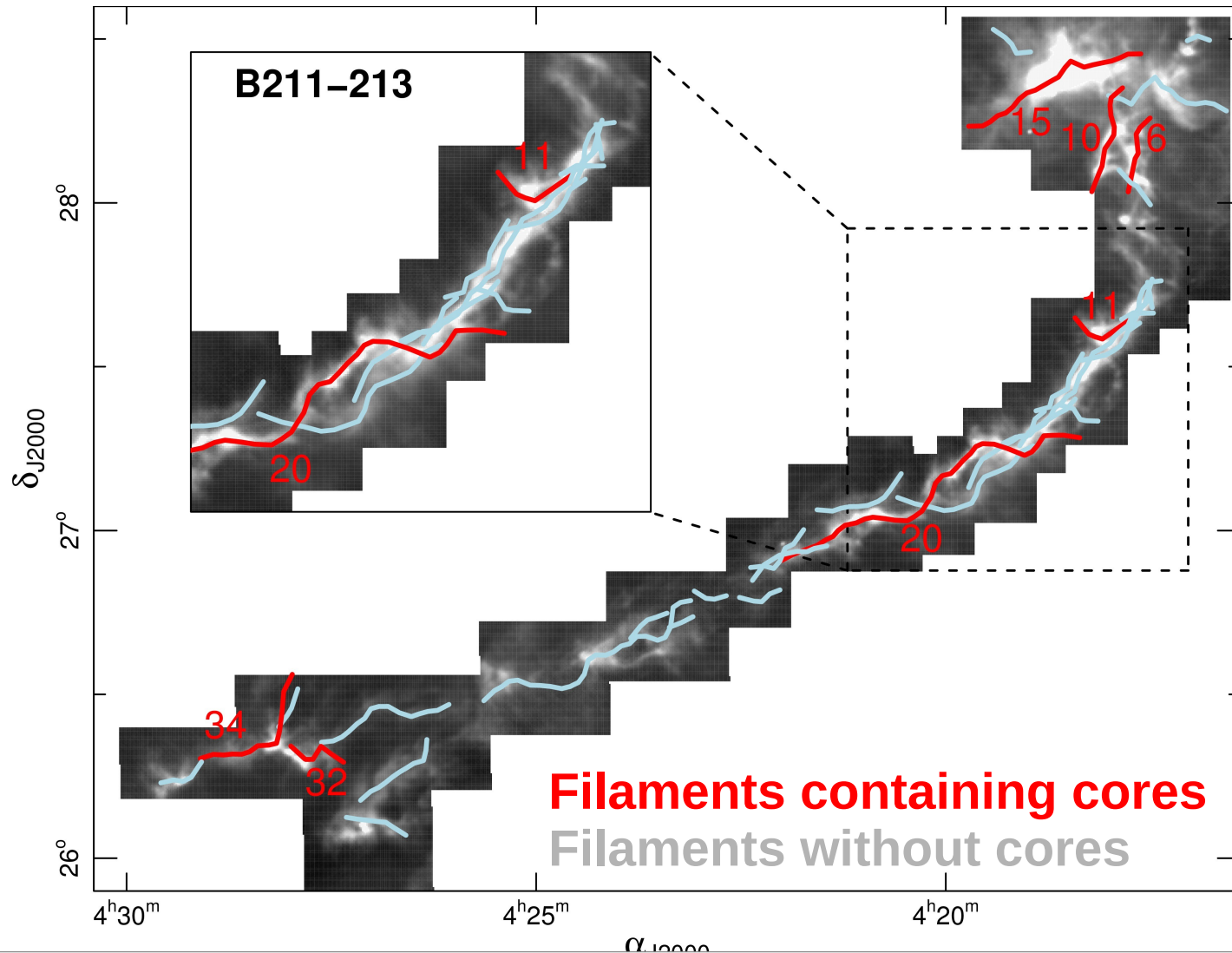


# Core clustering in B213 / L1495



- All cores embedded within velocity-coherent filaments
- Classically, coherent scale  $\sim 0.1$  pc (Goodman+98)
- **But cores form from a (tran-)sonic medium!**
  - velocity-coherent filaments at scales of  $\sim 0.5$  pc (also observed in Perseus, Pineda+)
- **Cores are located in groups  $\rightarrow$  clustered**

# Fertile vs sterile filaments



- Only few filaments ( $\sim 1/4$ ) form cores  $\rightarrow$  fertile
- While most of the filaments ( $\sim 3/4$ ) don't  $\rightarrow$  sterile
- **Fertile or Sterile**  $\rightarrow$  depending on  $M_{\text{lin}}$   $\rightarrow$  controls the SFE in MC?

# Dense core formation process: Hierarchical fragmentation within molecular clouds

