Massive filaments in Orion:
Morphology and profile fitting

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CONTEXT

- Filament shape and width can give important information about physical conditions within the ISM.
- The characteristic 0.1 pc width could be due to a transition point within filaments, but it can also be caused by observational effects (ex. resolution) and multiscale structure within the ISM.
- Many sources of error can affect filament fitting routines. These are not always known.

OBSERVATIONS AND METHODS

- Orion Molecular Cloud 3 (OMC-3)
  - d ~400 pc (Großschedl et al., 2018)
- With 3 instruments (Fig. 1)
  - **HR:** *Herschel* SPIRE (250, 350, 500 μm)
  - **AR:** Combined APEX ArTéMiS (350 μm) and SPIRE 350 μm
  - **MIR:** Spitzer (8 μm)
- Temperature, optical depth, and column density with modified blackbody fitting
- Extract filament segments (lines in Fig. 1)
  - The entire main filament (Fig. 1, left, center)
  - Four densest segments (Fig. 1, right)
- Fit profile models and extract parameters (e.g. *FWHM*) using Plummer function

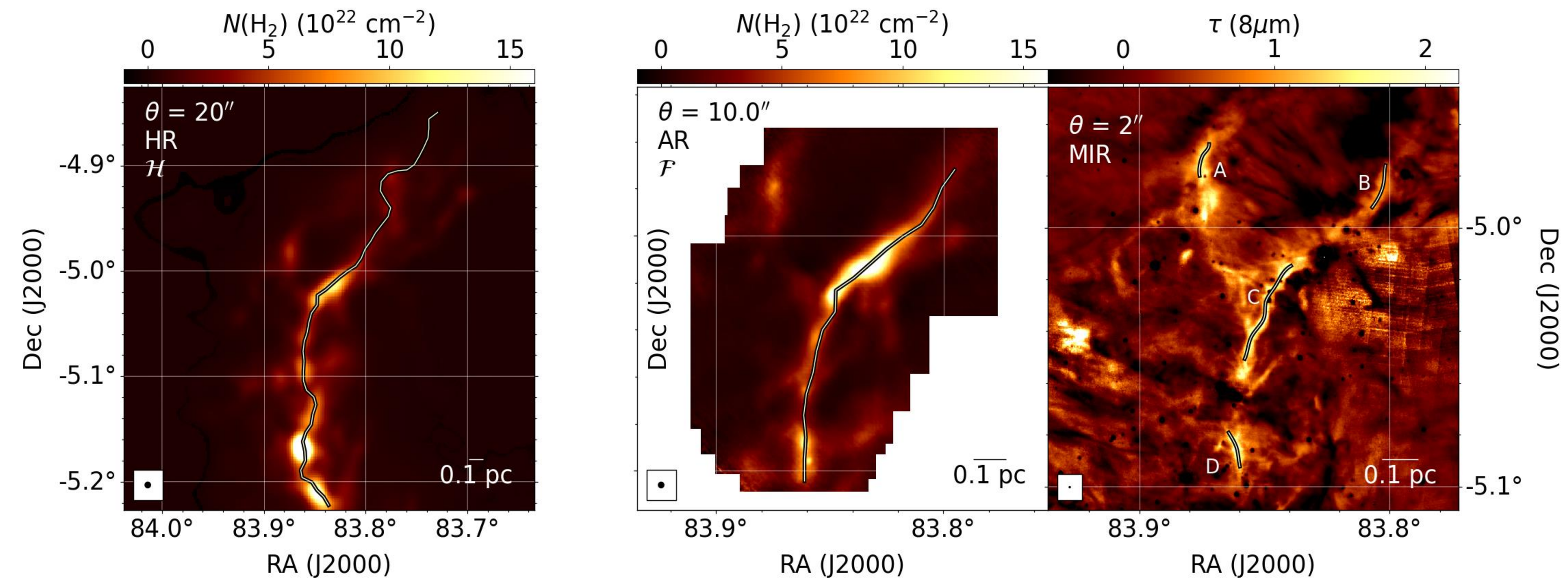

Fig. 1: OMC-3 column density maps with *Herschel* (left), ArTéMiS (center), and Spitzer (right). θ is the beamsize. The filament path in each field is marked by the line. Segments A-D were also extracted for the HR and AR data.

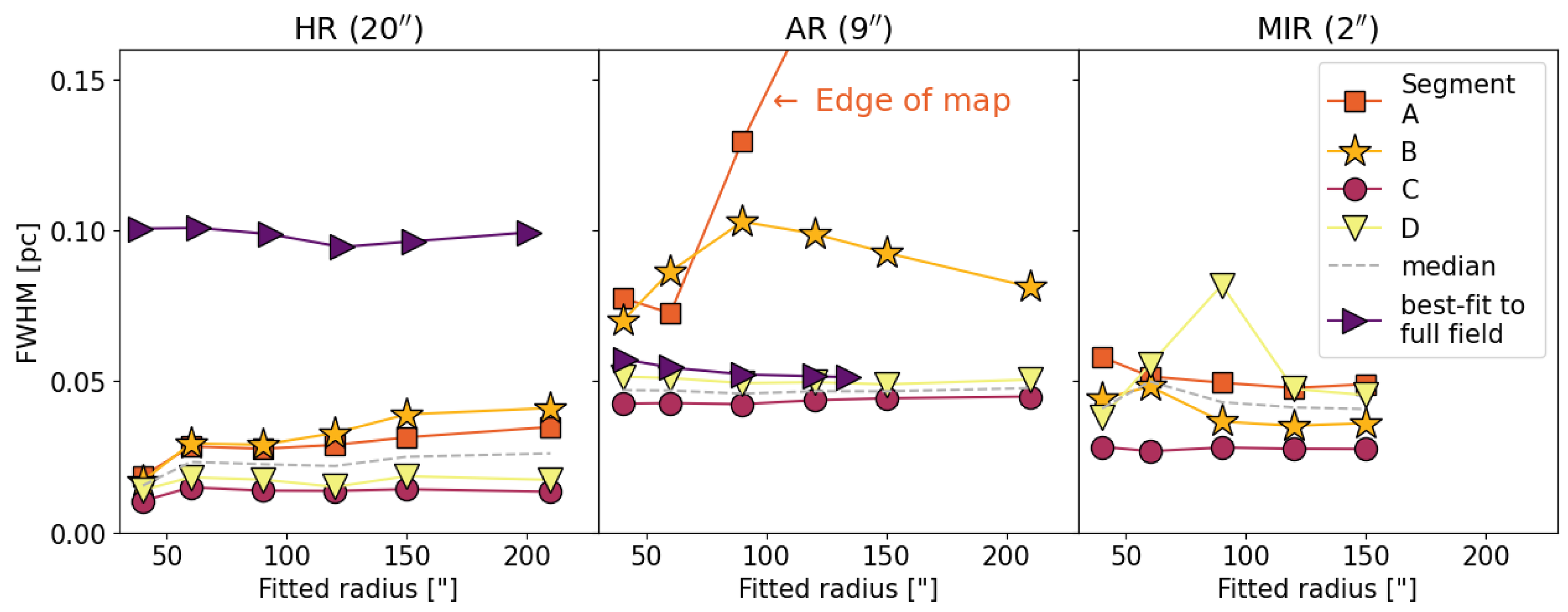

Fig. 2: Width *(FWHM)* of the filament segments. A-D correspond to the segments in Fig. 1 (right). The full field filament is shown in Fig. 1 (left,center).

EFFECT OF INTERSTELLAR RADIATION FIELD (ISRF) ON FILAMENT WIDTHS

- Massive SF filament, $N(H_2)$ varies
- SOC radiative transfer programs to calculate emission
- Mathis et al. (1983) ISRF (X = 1) and stronger ISRF (X = 10, 100)
- Higher N(H2) causes more error and higher derived widths (Fig. 3)
- But a stronger radiation field compensates for it

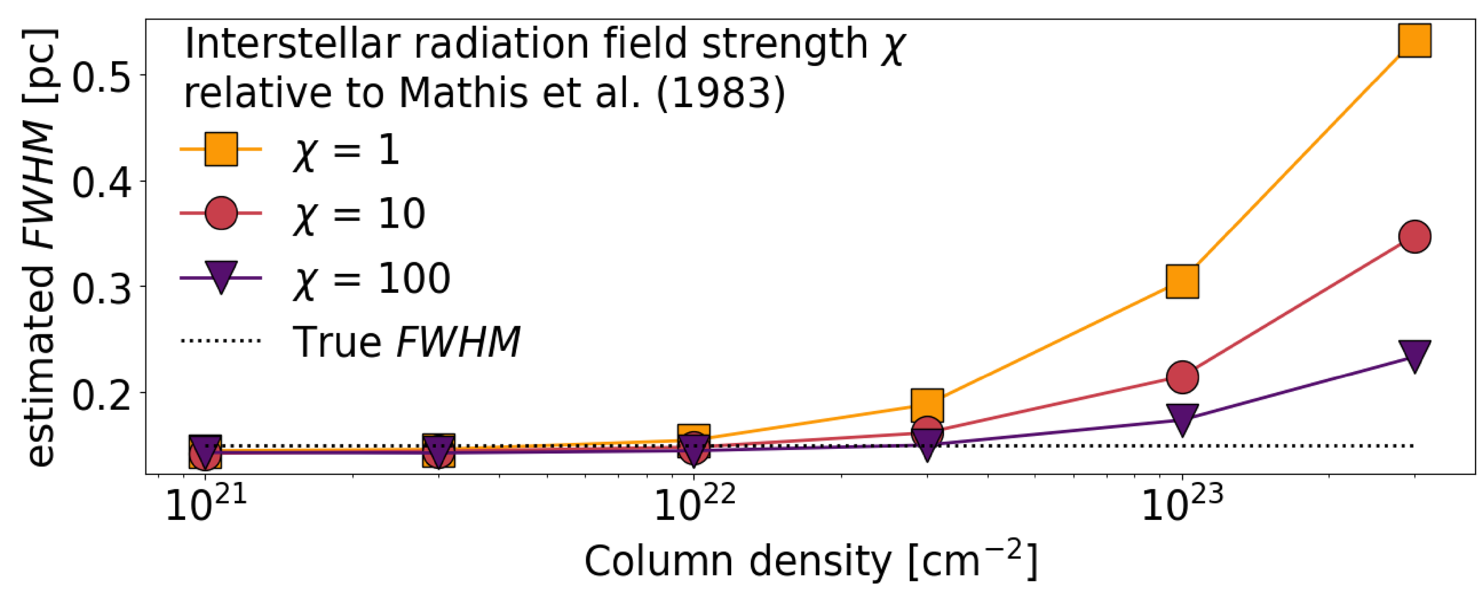

Fig. 3: Derived widths for a simulated filament, as a function of column density and assuming an ISRF like Mathis et al., (1983; X=1, yellow squares), 10 times stronger (X=10, red circles), and 100 times stronger (purple triangles).

RESULTS

- Full filament segments showed significant difference between HR and AR data (FWHM ~ 0.1 pc vs. FWHM~0.05 pc, purple triangles in Fig. 2)
- Filament segments do not show this difference (most show FWHM ~0.05 pc, red-orange markers in Fig. 2).

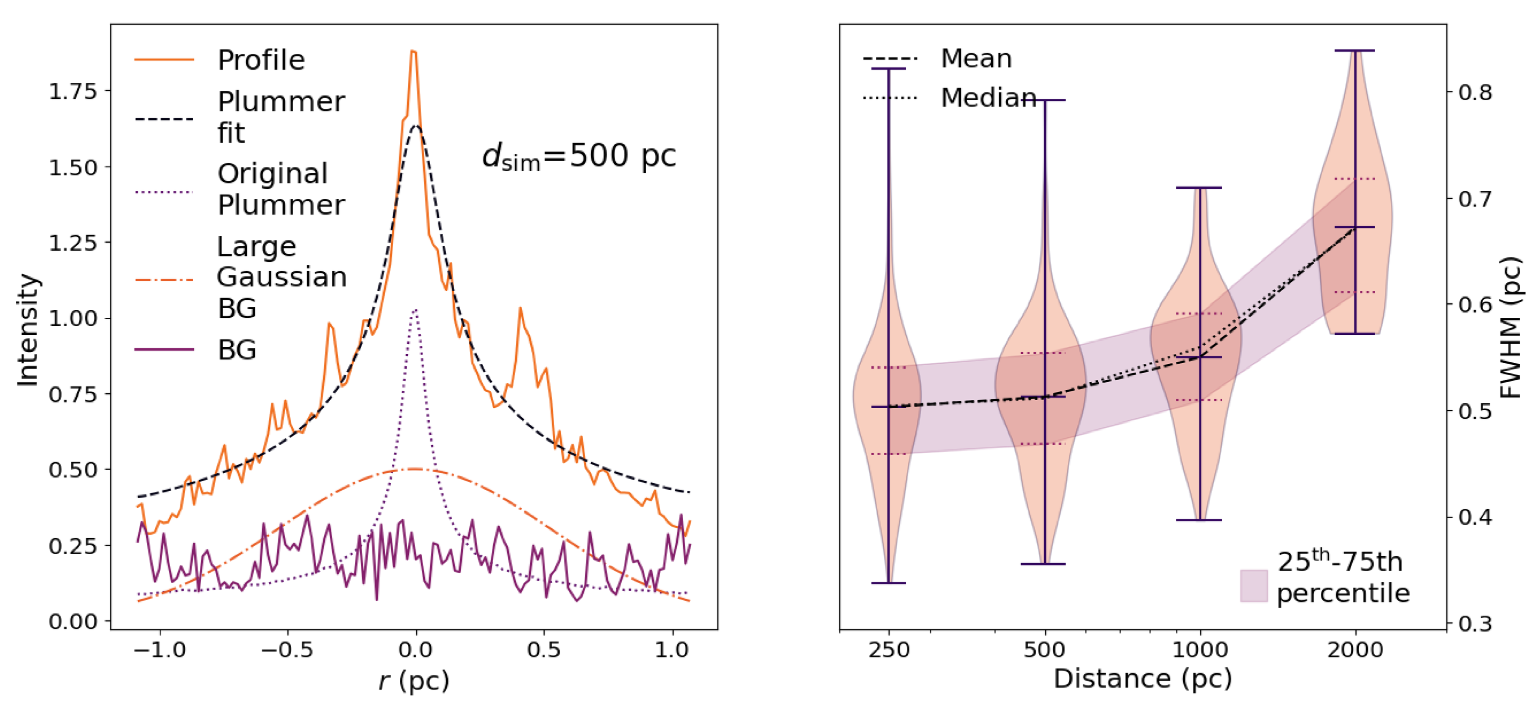

Fig. 4: Simulations on the effect of distance to a simulated filament. (left): The components: a random sky background (purple solid lines), a large Gaussian component to simulate hierarchial structure (orange dashed lines), and a Plummer-like filament (purple dotted lines). The resulting profile (at a simulated distance of 500 pc) Is shown with solid orange lines, and the Plummer fit with dashed black lines. (right): Violin plots of filament distance vs. Filament width.

EFFECT OF DISTANCE ON FILAMENT WIDTHS

- Simulated filament with a narrow Plummer, large Gaussian component, and sky background with powerlaw fluctuations. (Fig. 4, left)
  - The filament Is convolved to larger distances and fit with a Plummer
- Larger distances result in higher *FWHM (*Fig. 4, right)
- The distance dependence of filament width can be caused by hierarchial structure in the ISM.

References

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