Edges versus Bends: Gravitational Accelerations in Filaments

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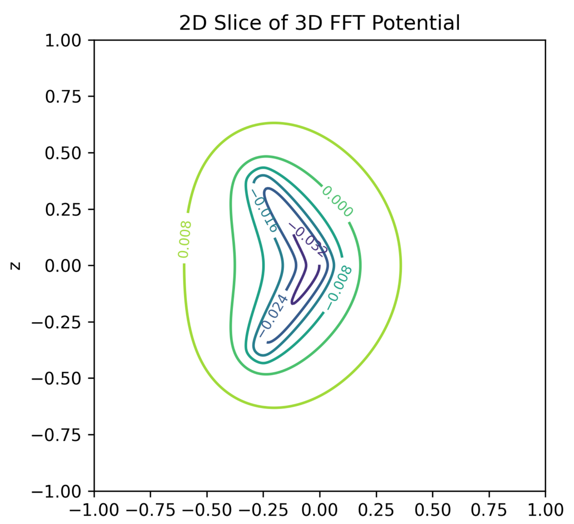
Motivation

- Filaments are one structure of molecular gas where star formation is observed.
- The collapse modes and evolution of finite bent filaments is not yet completely understood, and the current models do not completely align with observed star formation.
- There have been models of straight finite filaments where the expected conditions occur, a pile-up of matter at the ends; however, star formation is not always seen in the ends.
- The structure of a straight filament supports more formation at the ends, so there must be other factors, such as a bend or kink or smoothing of the ends of the filament.
- My goal: model bent filaments and see if there is a point where the bend dominates

Filament Modeling

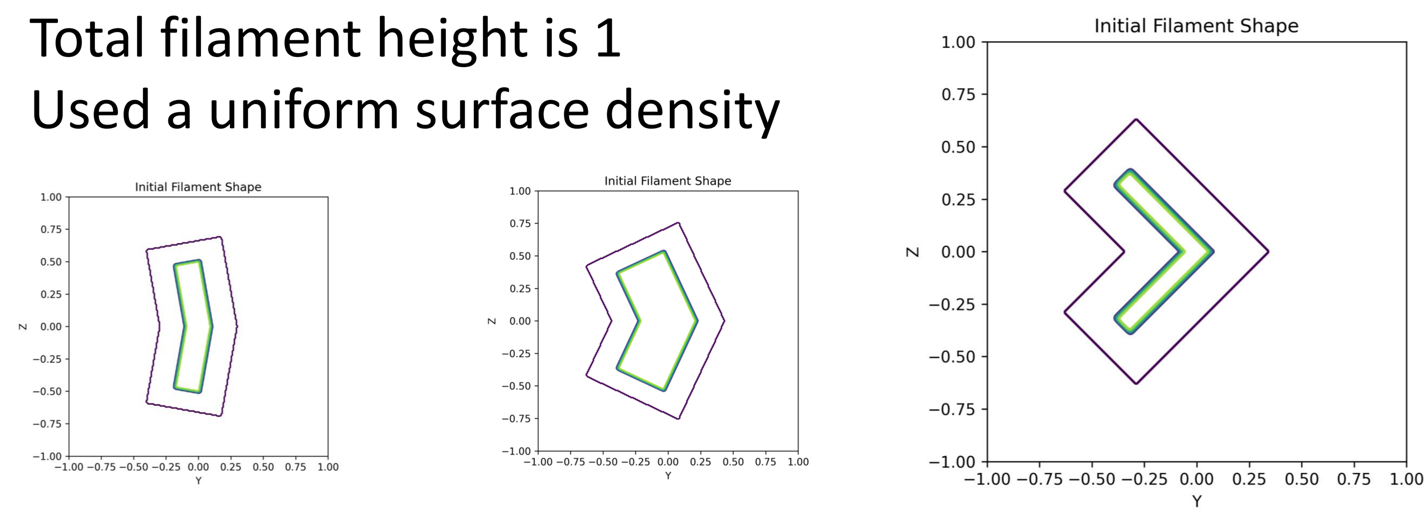
$$\nabla^2\phi = 4\pi G\rho$$

- Solved Poisson's equation for gravity numerically using Fast Fourier Transforms to find the gravitational potentials
- ϕ is the scalar potential
- G is the gravitational constant
- ρ is the initial surface density
- Accelerations can than be found by taking the negative gradient of this result

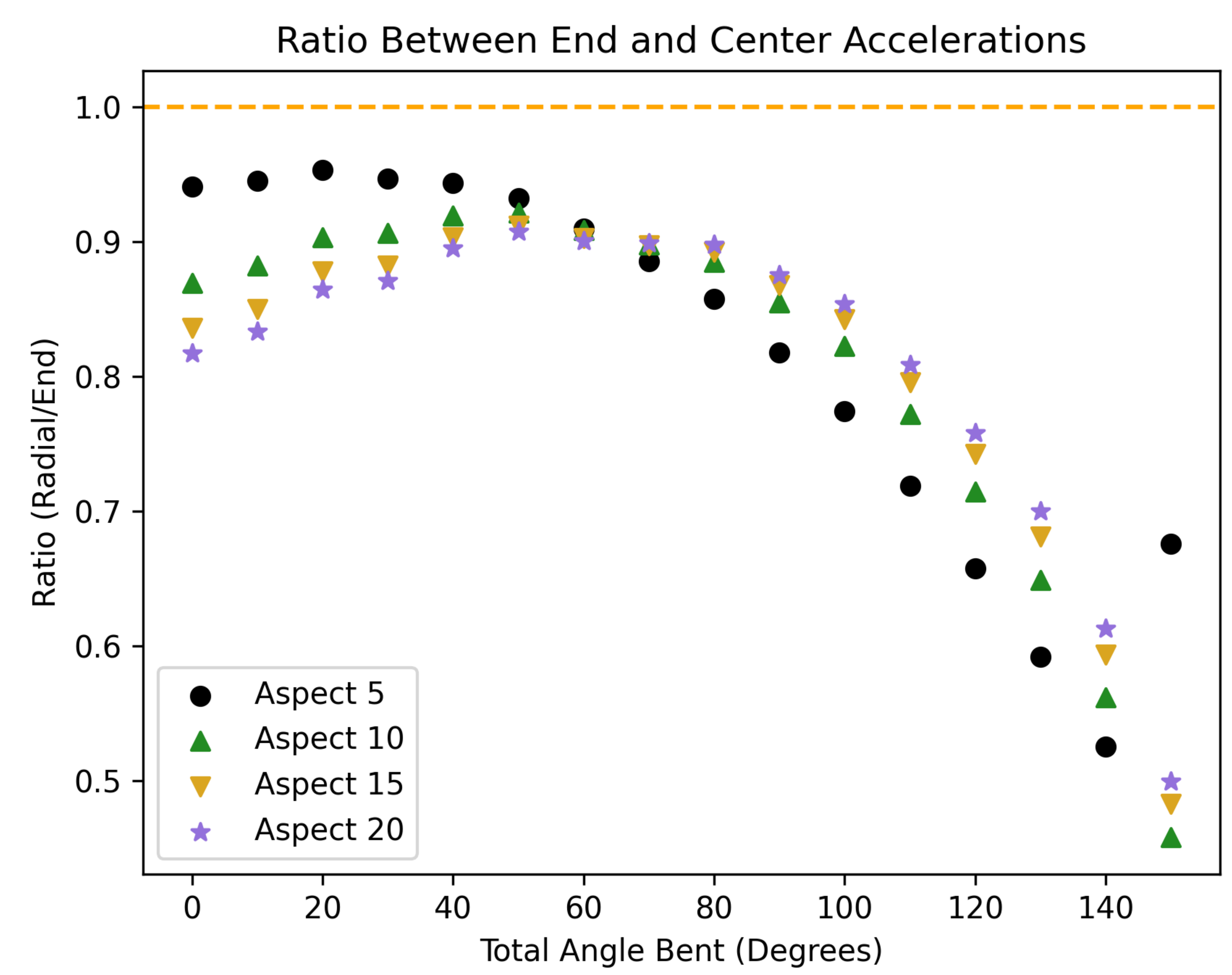


Initial Conditions

- Tested different total bend angles at varying aspect ratios.
- Aspect ratio is the ratio between the height and the radius.
- Total filament height is 1
- Used a uniform surface density



Can the accelerations at the bends "win" over the accelerations at the ends?

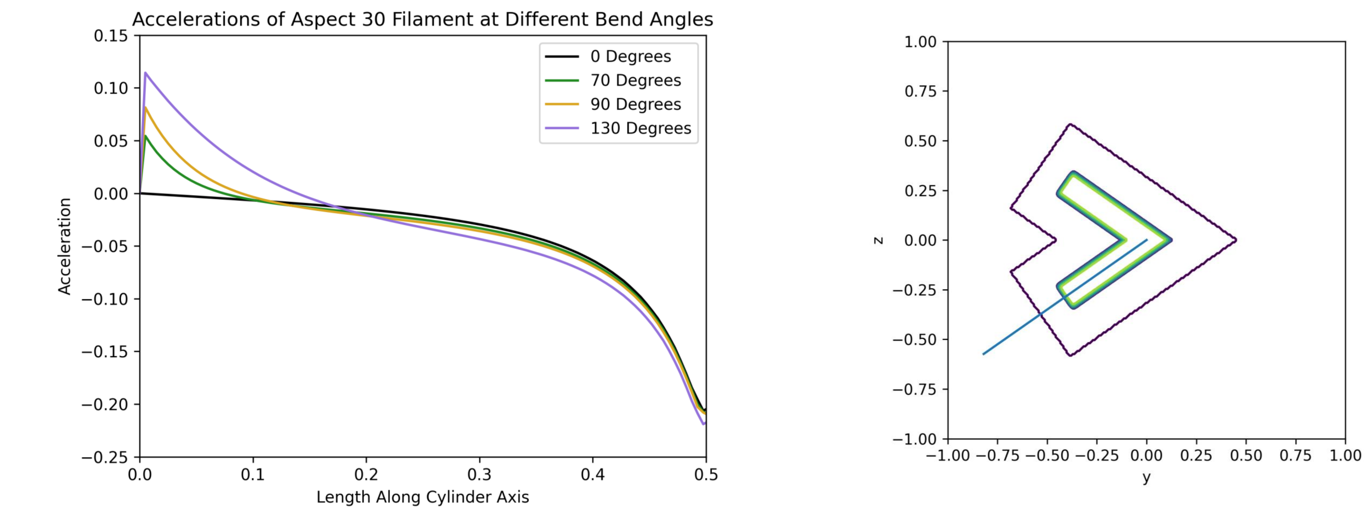


Conclusion and Future Work

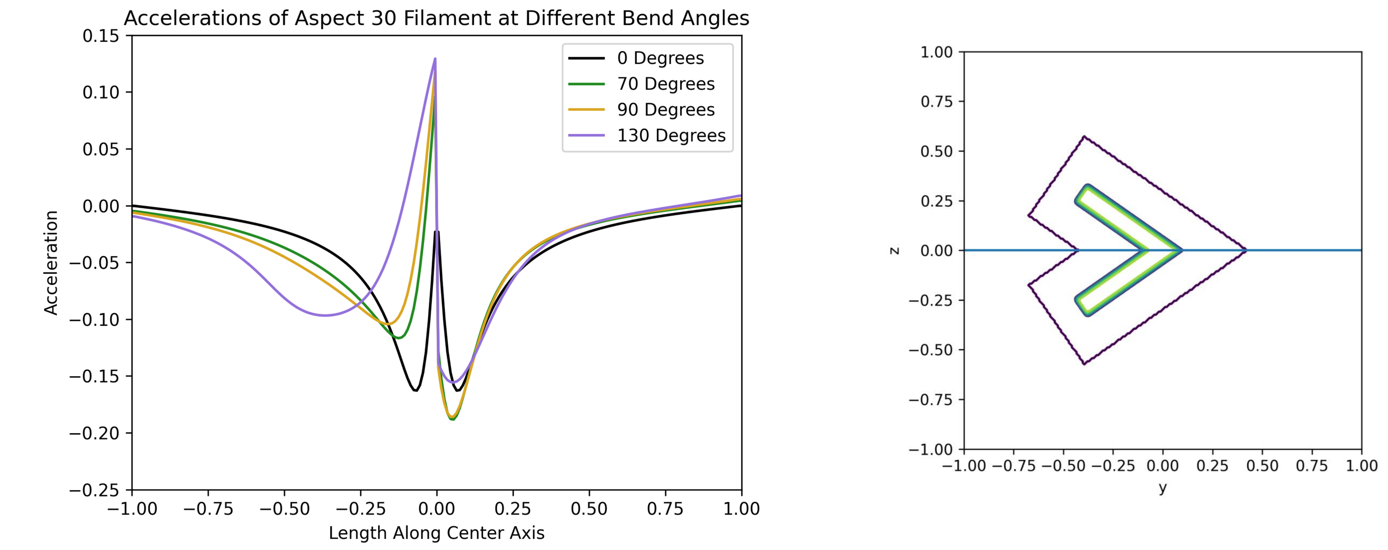
- Without smoothing out the ends, there are no angles where the bend causes a greater acceleration than the that at the ends.
- Repeat tests with realistic values for the initial densities instead of uniform values.
- Find the accelerations for filaments with varying levels of smoothing of the ends.

Accelerations

- Accelerations projected along one half of the bent filament, from the center to the end.
- When there is no bend, the accelerations go to zero as they approach the bend.
- However, with a bend in the filament, there is an opposing acceleration from the center that increases with the bend angle.



- Accelerations projected across the center of the filament.
- Again, with no bend this behaves as expected.
- With some bend, the accelerations on the outer side of the filament increase in magnitude.
- However, as the bend increases and both ends approach each other, the mass from both halves of the filament contribute to the acceleration.



References

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4. Image: ESO/APEX (MPIfR/ESO/OSO)/A. Hacar et al./Digitized Sky Survey 2. Acknowledgment: Davide De Martin.

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