Solar Wind – Comet Interaction: Global 3D Hybrid Code Simulation Study

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The hybrid model

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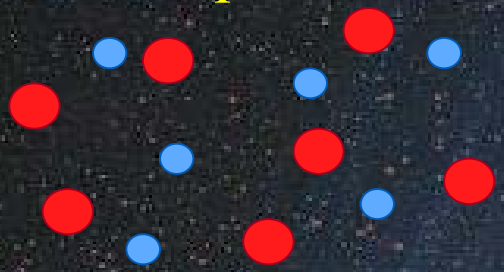
Full particle



Ions & Electrons as particles

- Complete physics
- Very expensive

Small scales

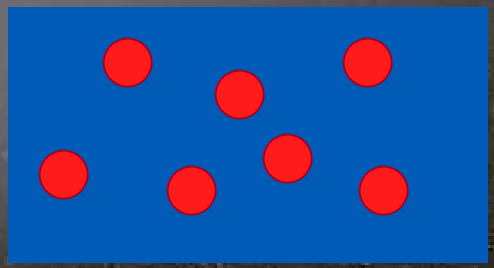
Multi-fluid

Ions & Electrons as fluid

- Fast & easy
- No kinetic effects

Large scales

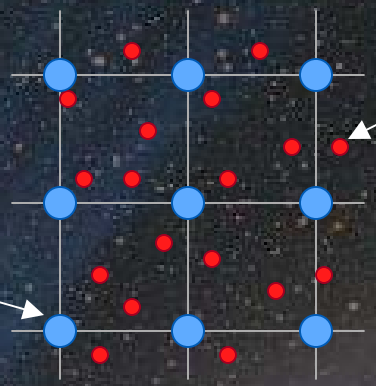
Hybrid model



Ions as particles, electrons as fluid

Intermediate scales

Numerical method



„Gather“: x, v ⇒ ρ, j

Field update: j, ρ ⇒ E, B

„Scatter“: E, B ⇒ E, B

„Particle Push“ E, B ⇒ x, v

Δt

Classical picture of a strong comet

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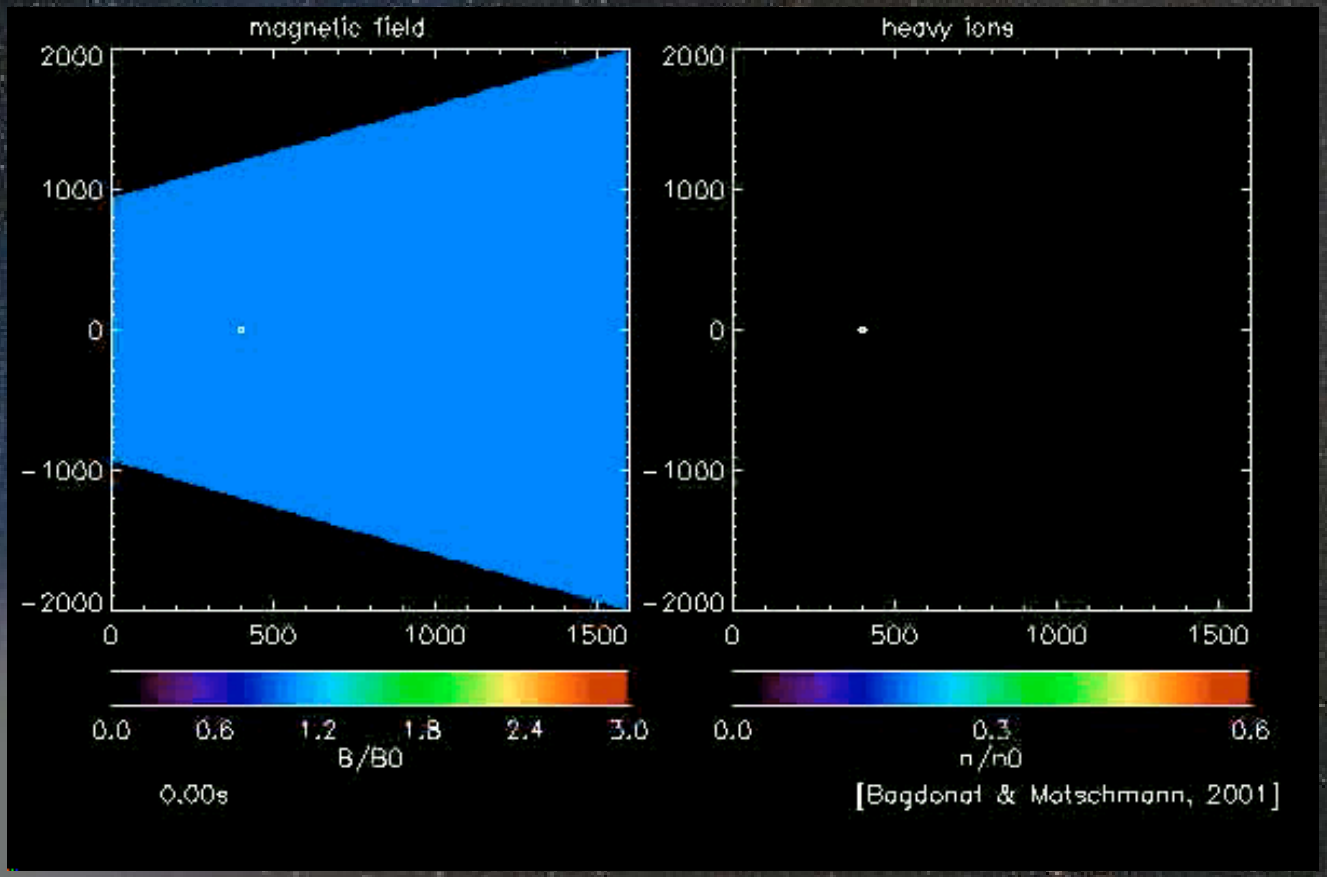
„Halley“-type comet

- Shock
- Cavity
- Turbulence



compare with [Hopcroft & Chapman, 2001]

The cycloidal motion

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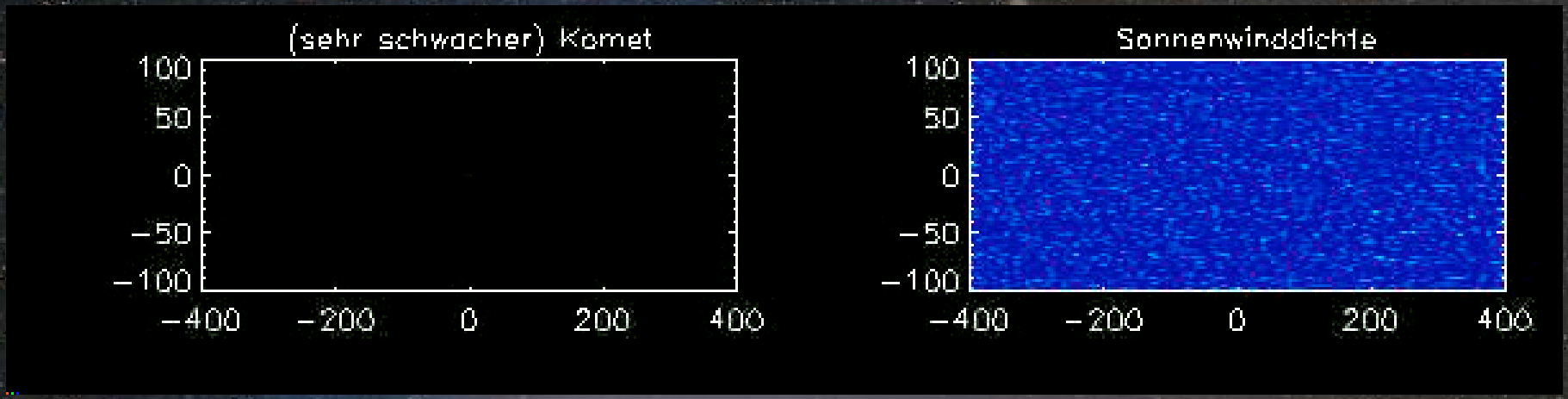
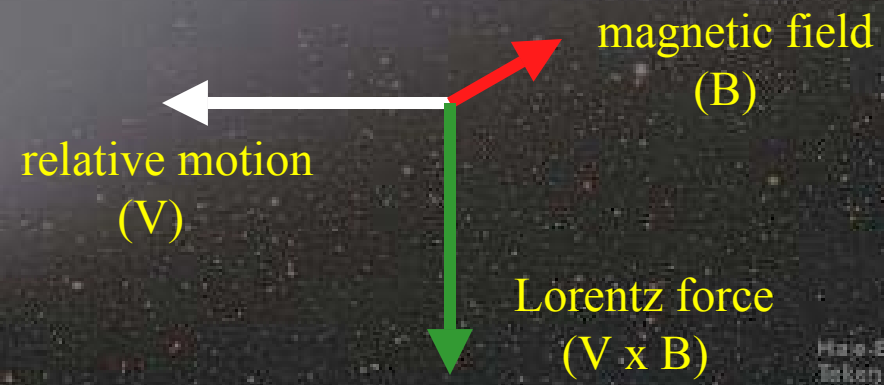
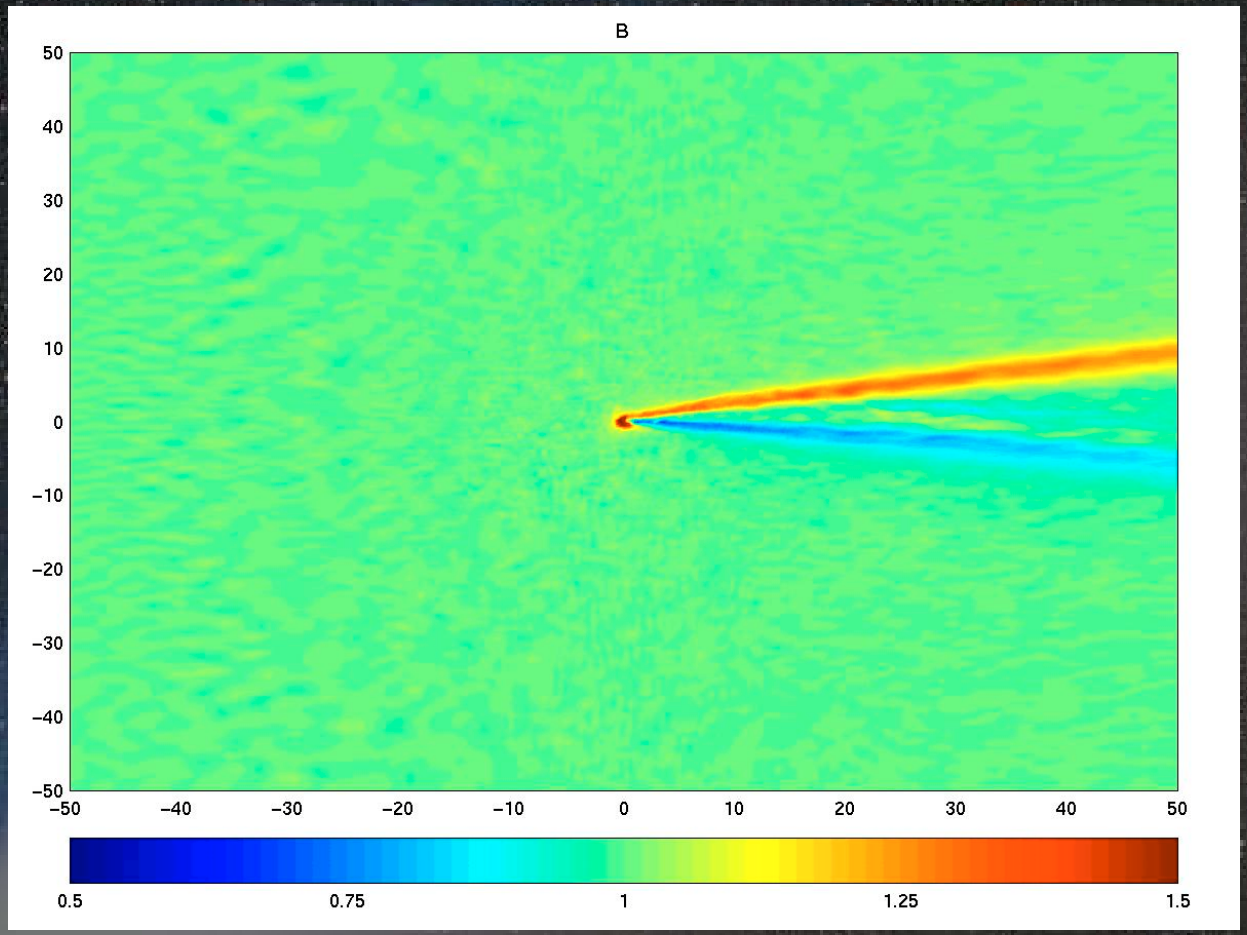
Cometary frame: „Test particles“ perform cycloidal motion (pickup)



Solar wind rest frame: „Test particles“ perform a circular motion



Linear Mach cone



Small obstacle produces a Mach cone

Weak comet dynamics (Large Scale)

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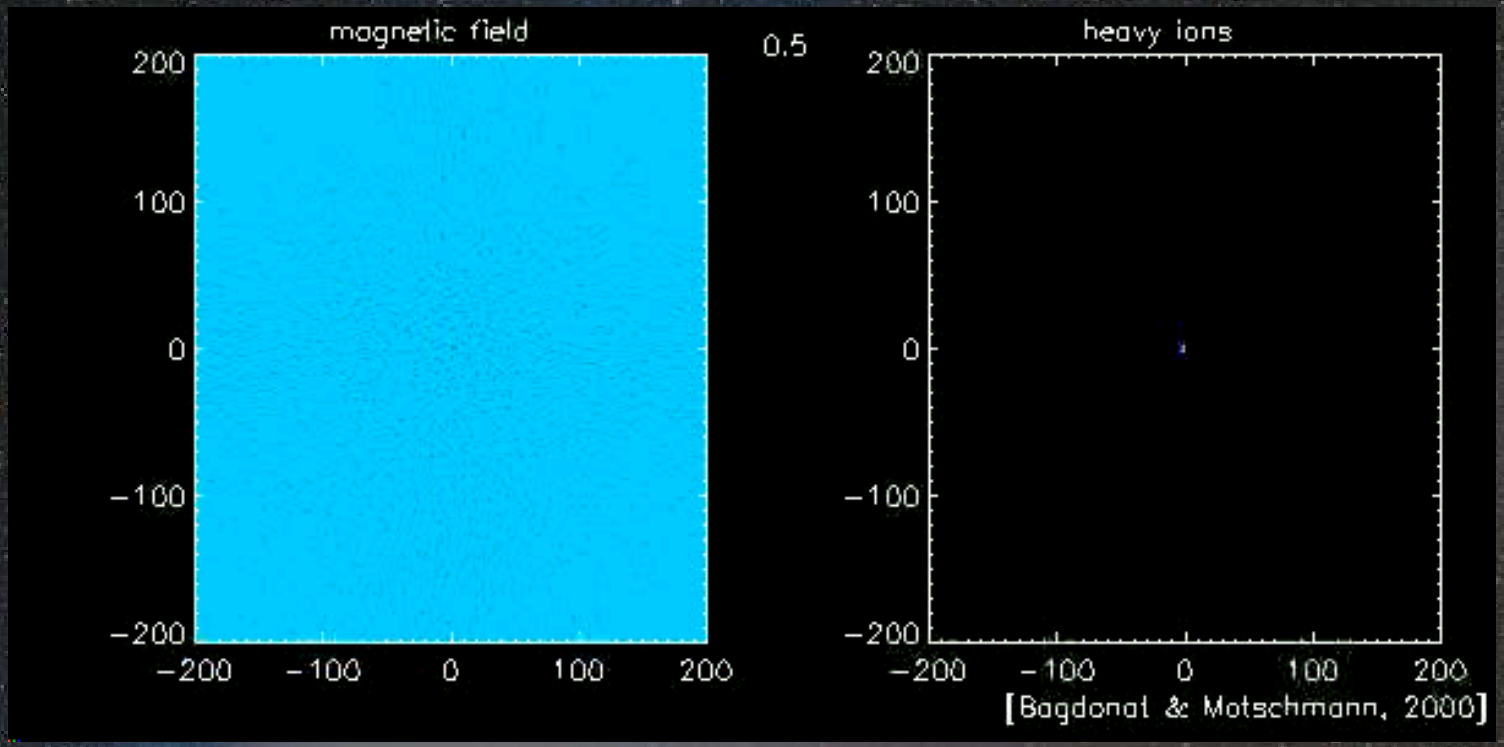

Tail structuring: „bi-ion acoustic wave“

[Bogdanov *et al.*, 1996] (multi fluid)

From a weak to a strong obstacle

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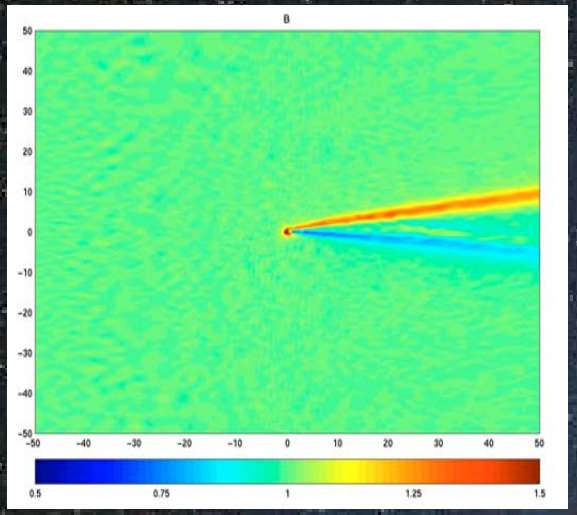
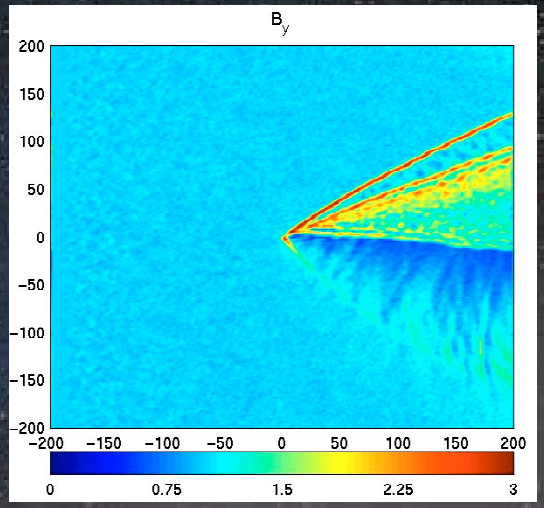
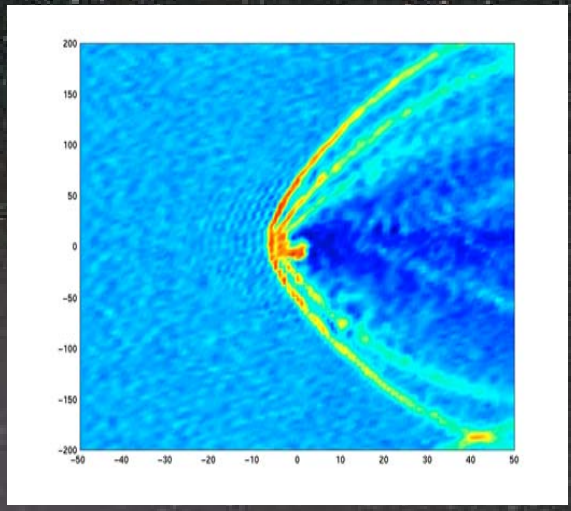


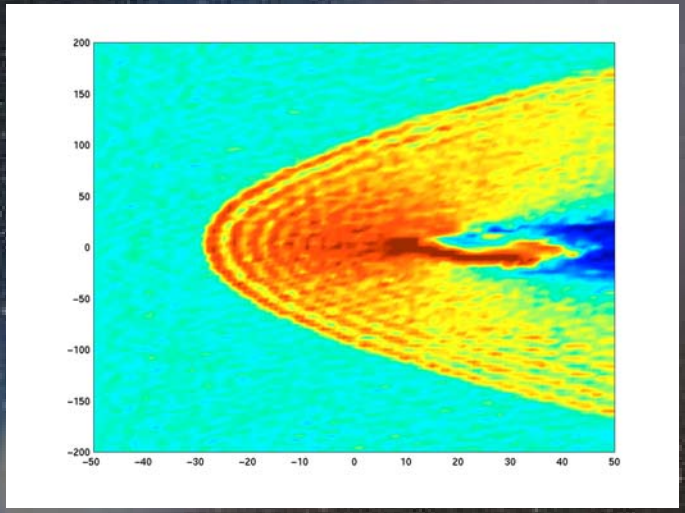
Classic,linear Mach cone



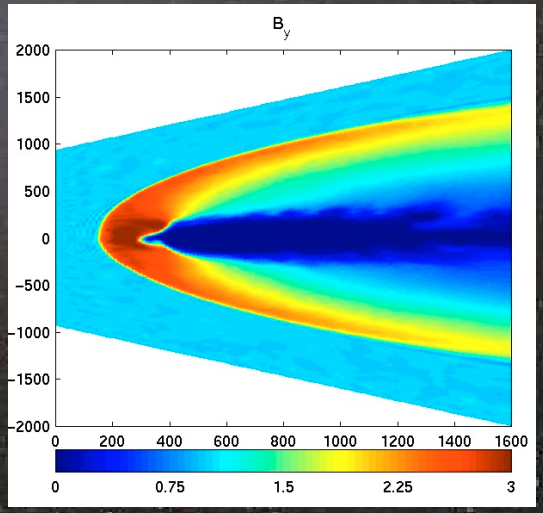
Multiple, nonlinear Mach cones



Symmetric case



Multiple shocklets



Parabolic shock

Comet Wirtanen: Simulation of an expected scenario

Wirtanen at 3.5AU

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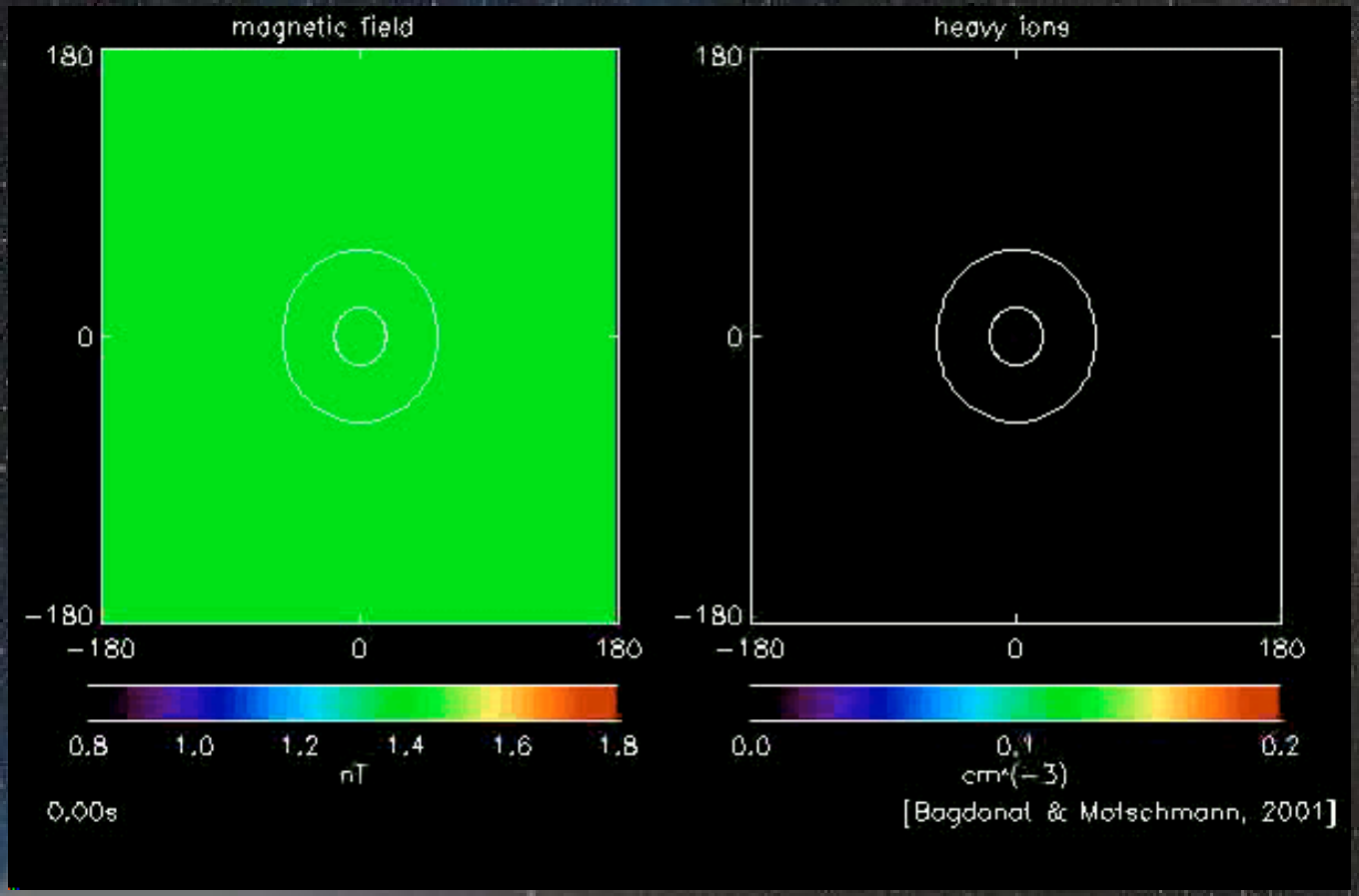

At 3.5AU Wirtanen has mainly a cycloidal tail
SW is rather undisturbed, no shock, no cavity

Wirtanen at 3.25AU

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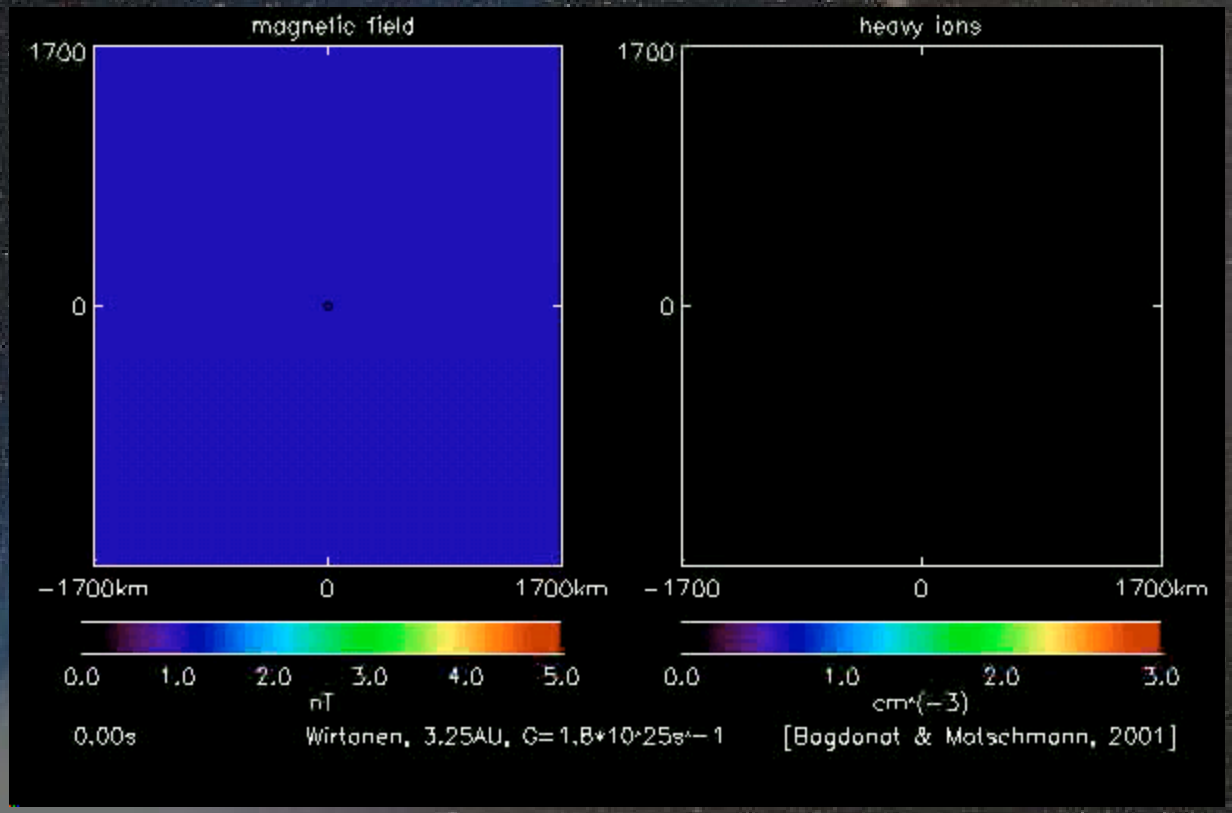

Wirtanen at 3AU

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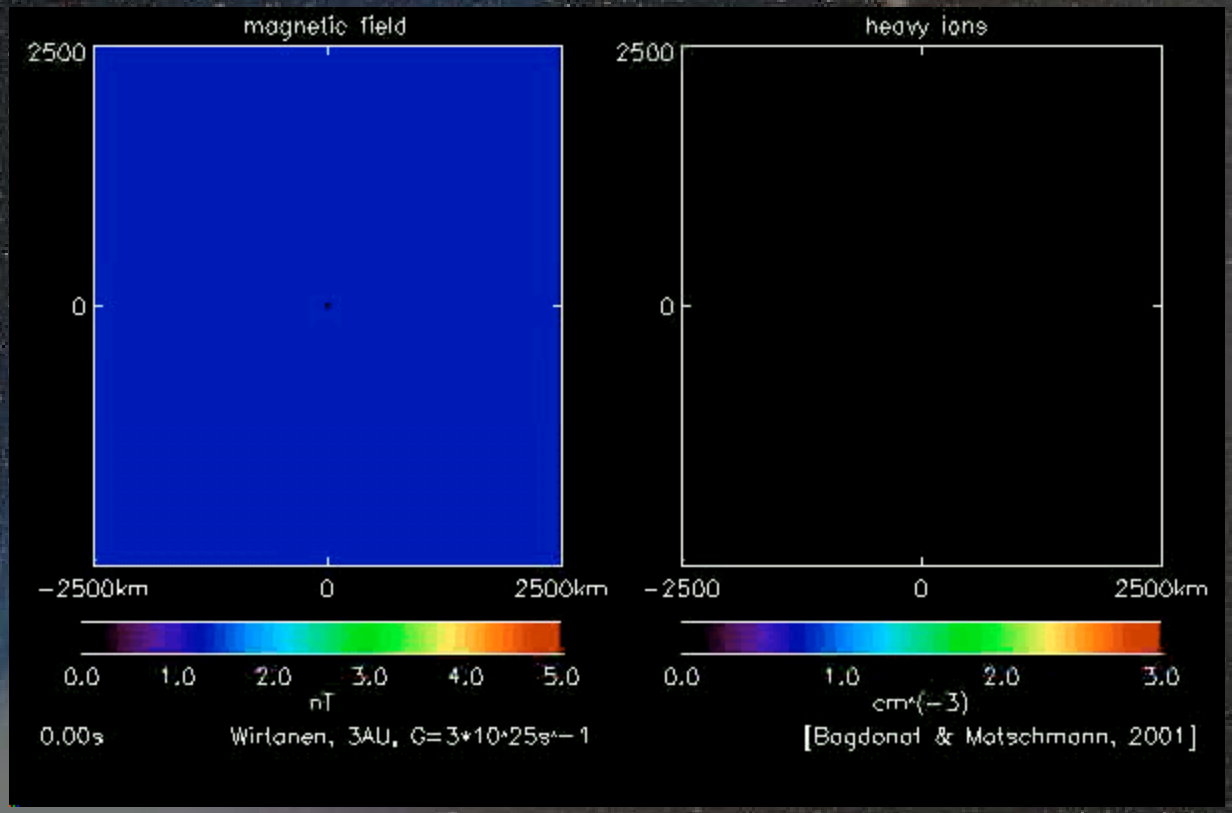

Wirtanen at 2.8AU

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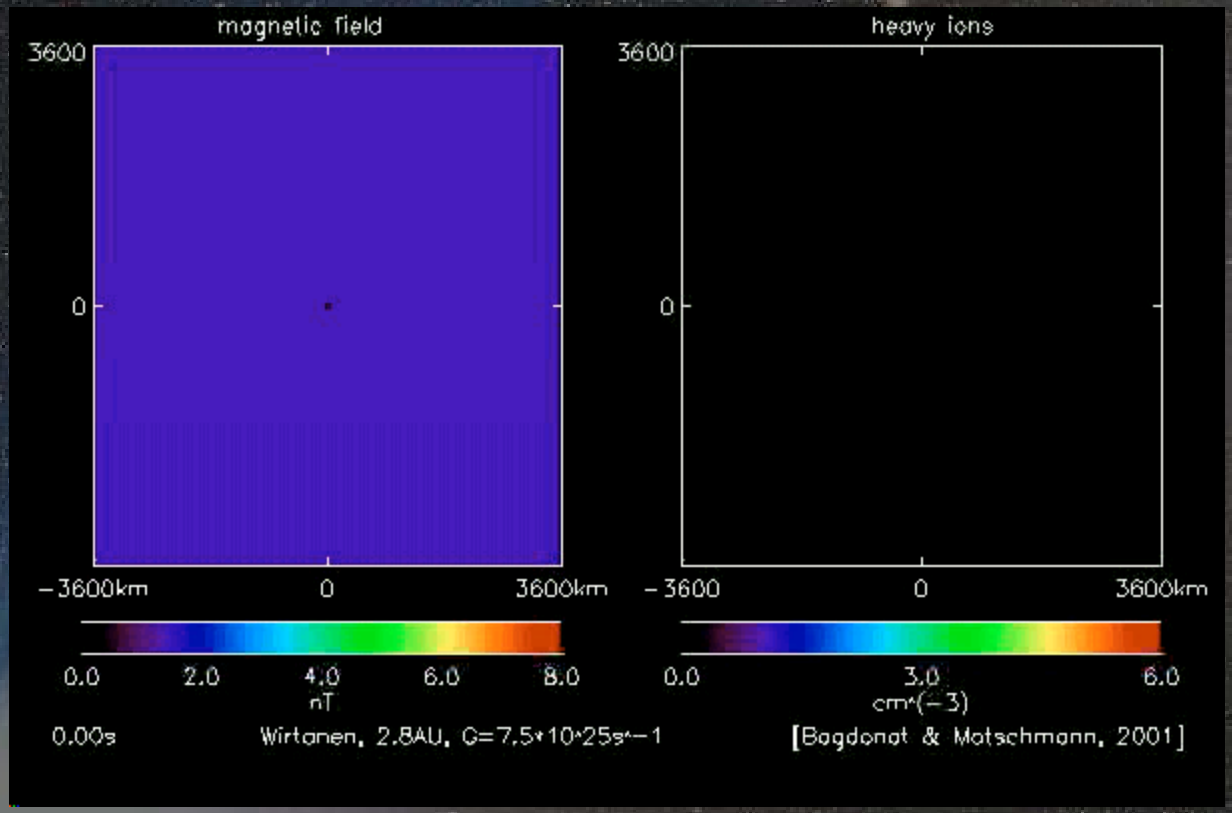

Wirtanen at 2.5AU

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