Massloading

1d hybrid code simulations

Injection of ions

Super/sub alfvenic flows

perpendicular/quasiparallel magnetic fields

Weak/strong injection

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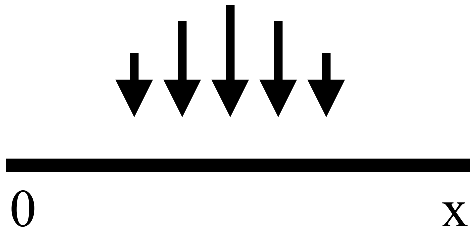
Simulation box

(a)
Local injection
of test particles

(b)
Distributed injection
of massive particles



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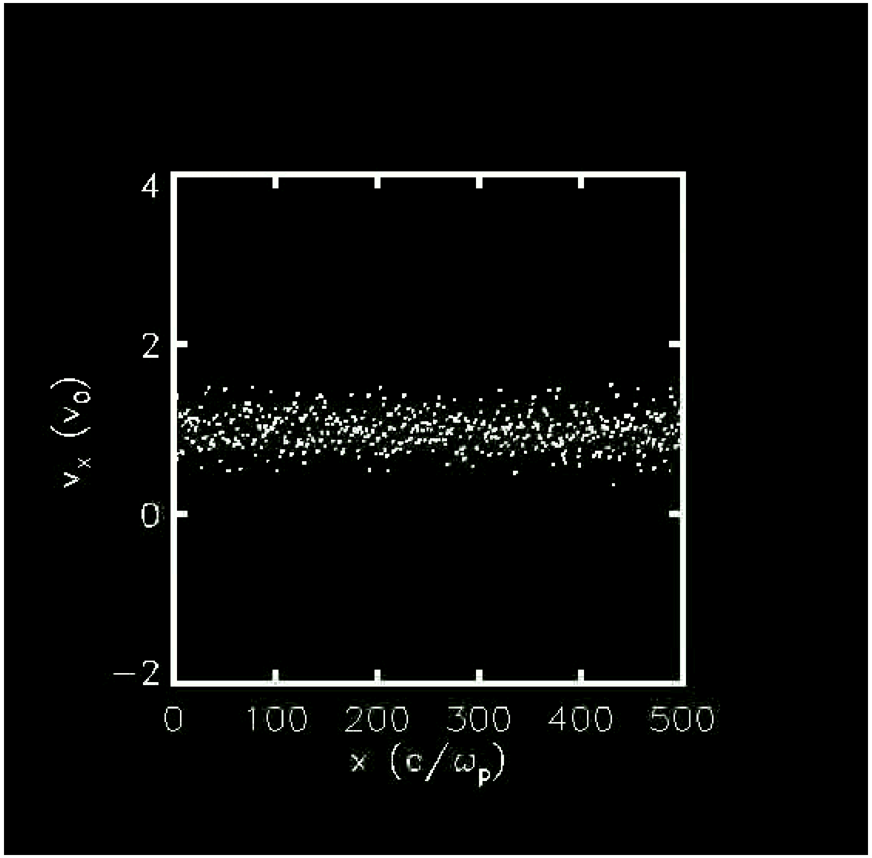
Flow without pickup



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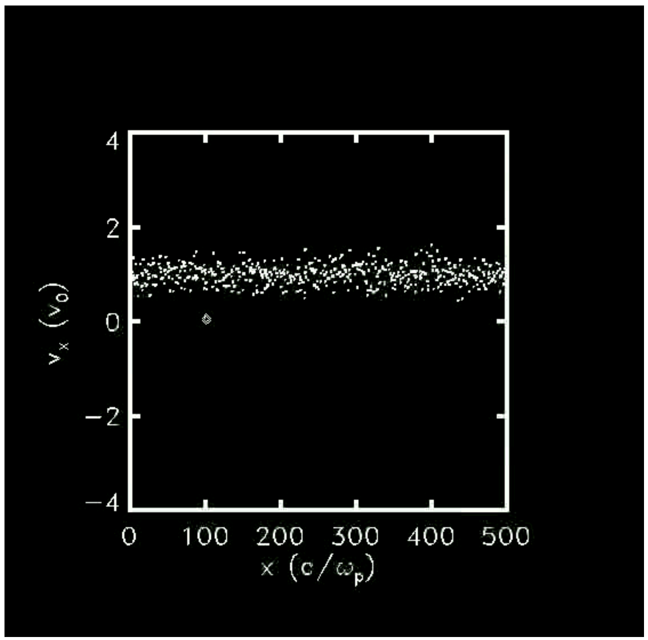
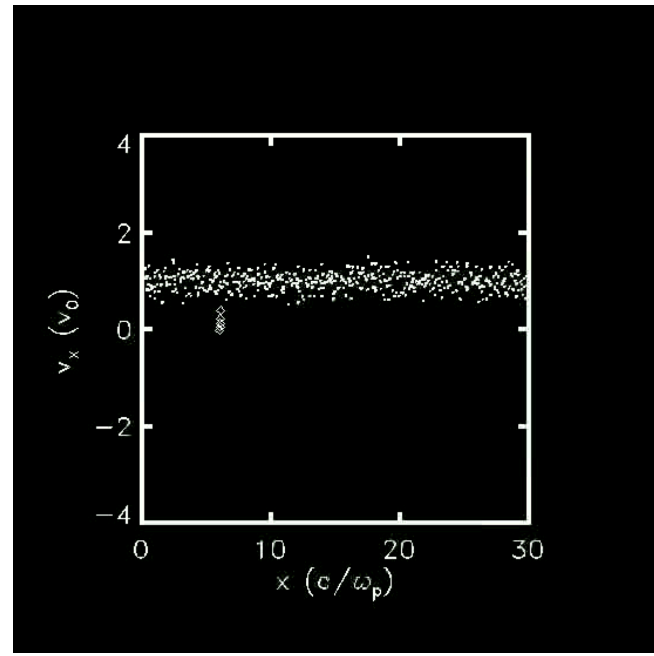
Injection of test particles

? = 90°, super_alfvenic



M_A=16
r_g = 16
? = 2 p r_g ≈ 100

? = 90°, sub_alfvenic



M_A=0.5
r_g = 0.5
? = 2 p r_g ≈ 3

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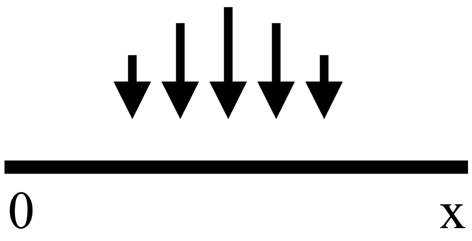
Injection of massive particles

-no injection point but gaussian shaped injection region



-thermal velocity $<$ background flow velocity

-weak but finite injection rate (no strong obstacle, no shock)

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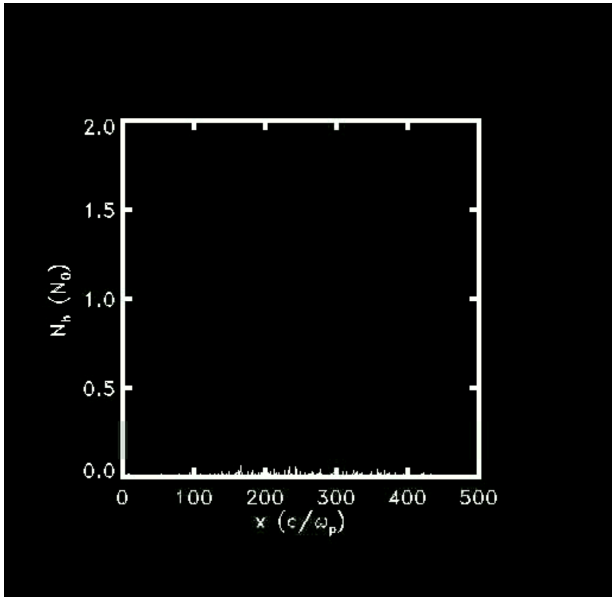
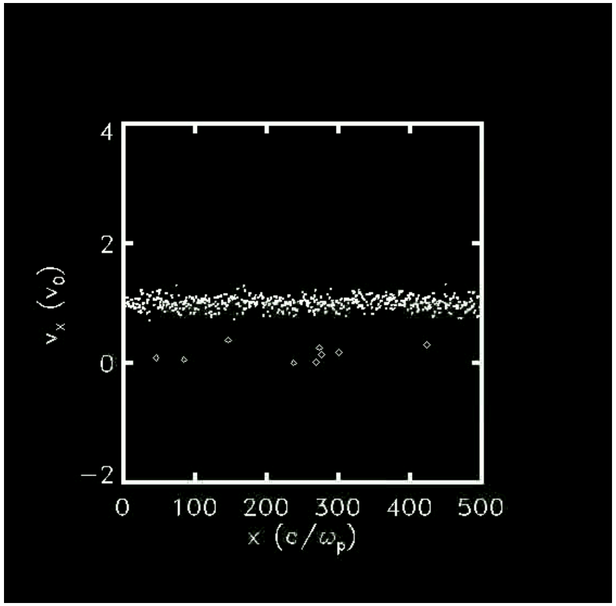
Superalfvenic, perpendicular

? = 90°





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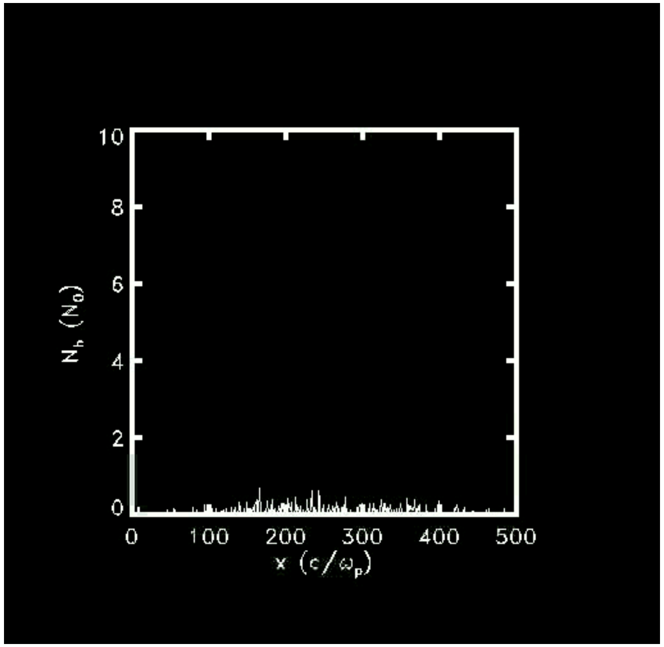
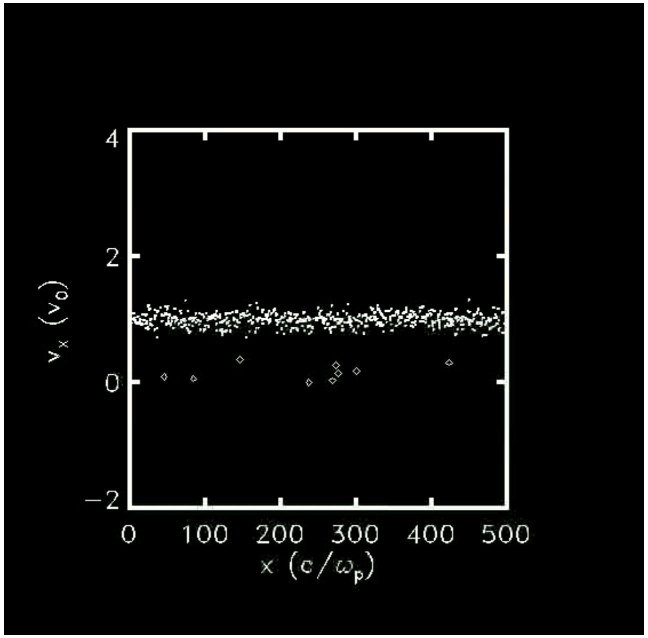
Superalfvenic+strong injection=shock





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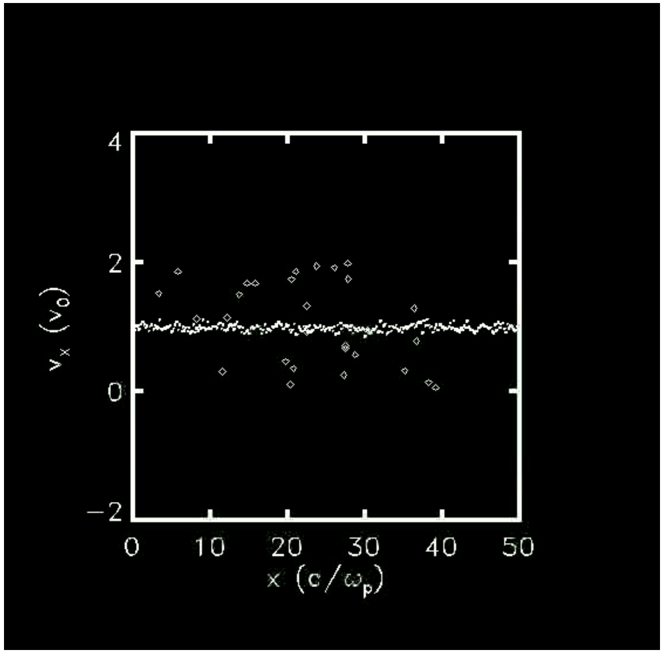
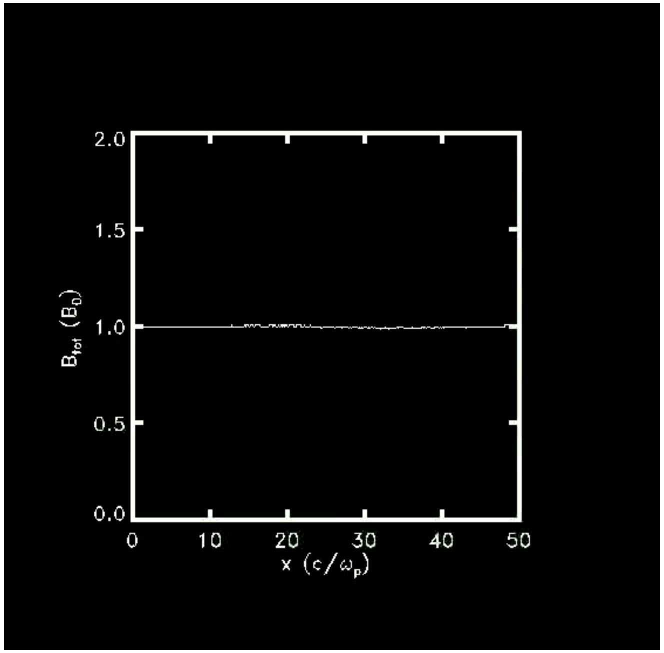
Subalfvenic, perpendicular

? = 90°





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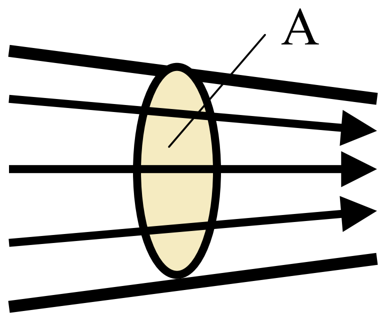
Equivalence of massloading and nozzle

Nozzle



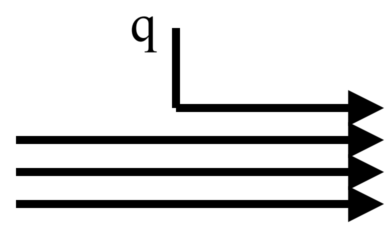
$$\rho \; u \; A \; = \; const$$

$$\rho \; u \; d_x u \; = \; -d_x \; p$$

$$p \; = \; c_s^2 \; \rho$$

increasing mass flow density

Massloading



$$d_x(\rho \; u) \; = \; q > 0$$

$$\rho \; u \; d_x u \; = \; - \; d_x \; p \; - \; d_x \; B^2/2\mu_0$$

$$p \; = \; c_s^2 \; \rho$$

$$B^2 \; = \; v_A^2 \; \mu_0 \; \rho$$

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