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Hybrid Simulations of Multispecies Z-pinch Plasmas

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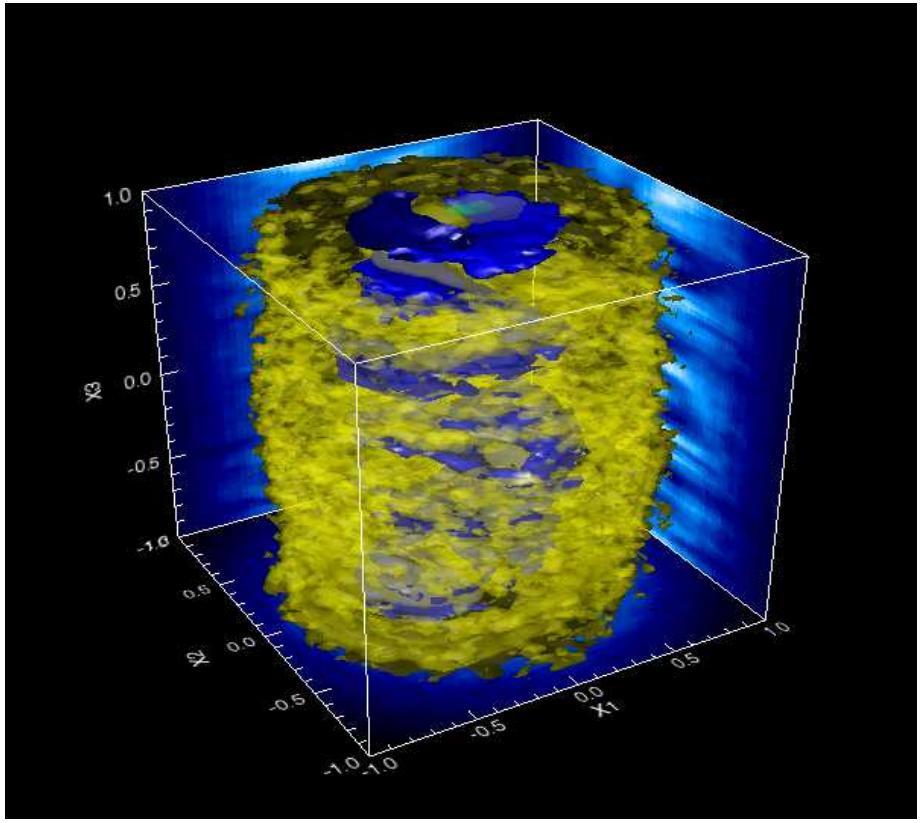
Goals

- To investigate the growth rates of sausage and kink instabilities for different density ratios of light and heavy ions.
- To determine kinetic energy partition between light and heavy plasma components
- To analyze magnetic field and current distribution inside the pinch
- To examine influence of ion-ion collisions on development of sausage and kink instabilities and temperature relaxation processes

Magnetic field at t = 80

Light ions density: 99% Heavy ions density: 1%
Light to heavy ion mass ratio: 1/100



Density of light ions at t = 80

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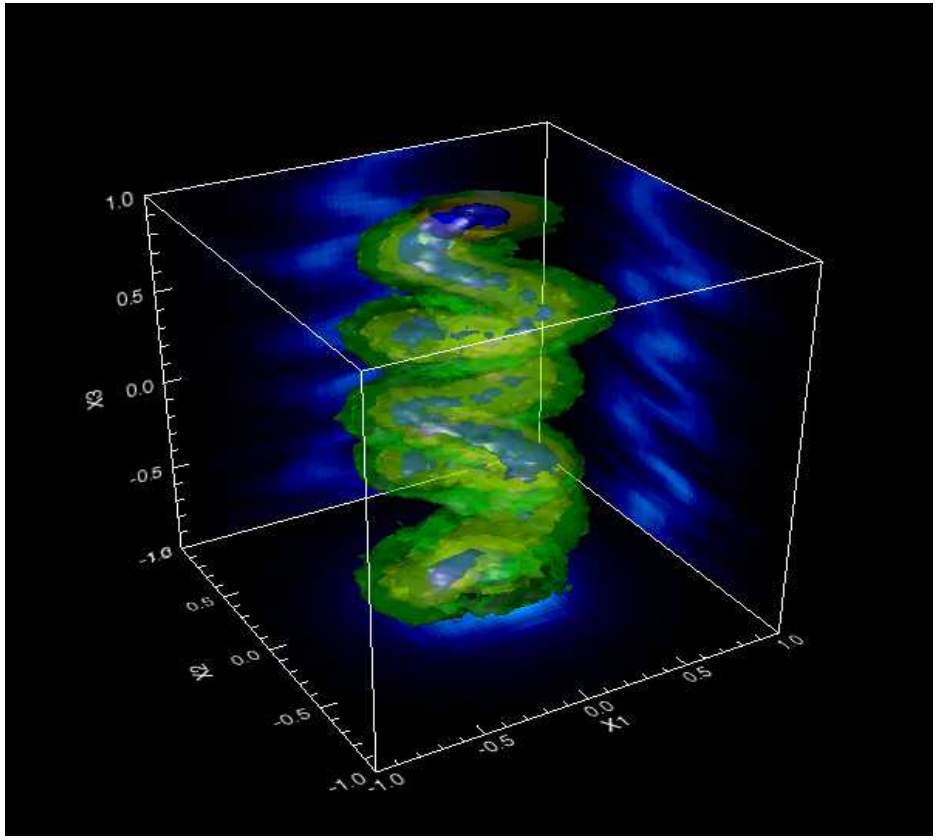

Density of heavy ions at t = 80

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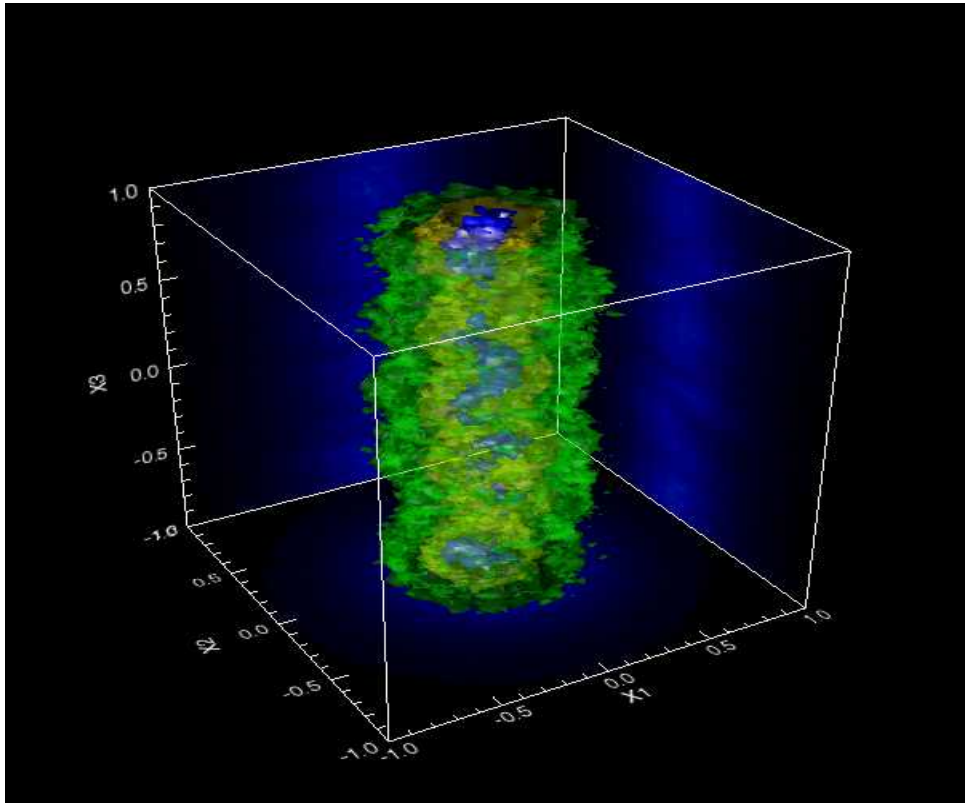
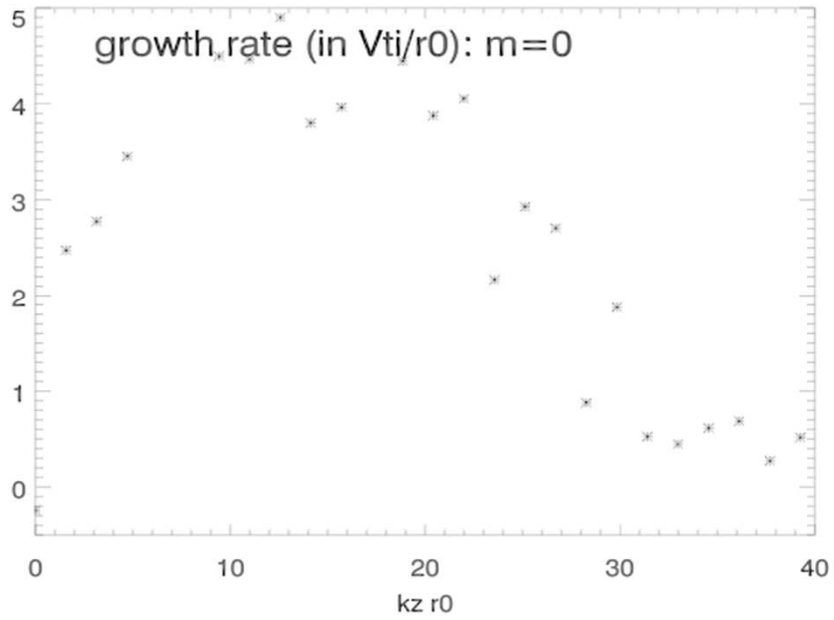


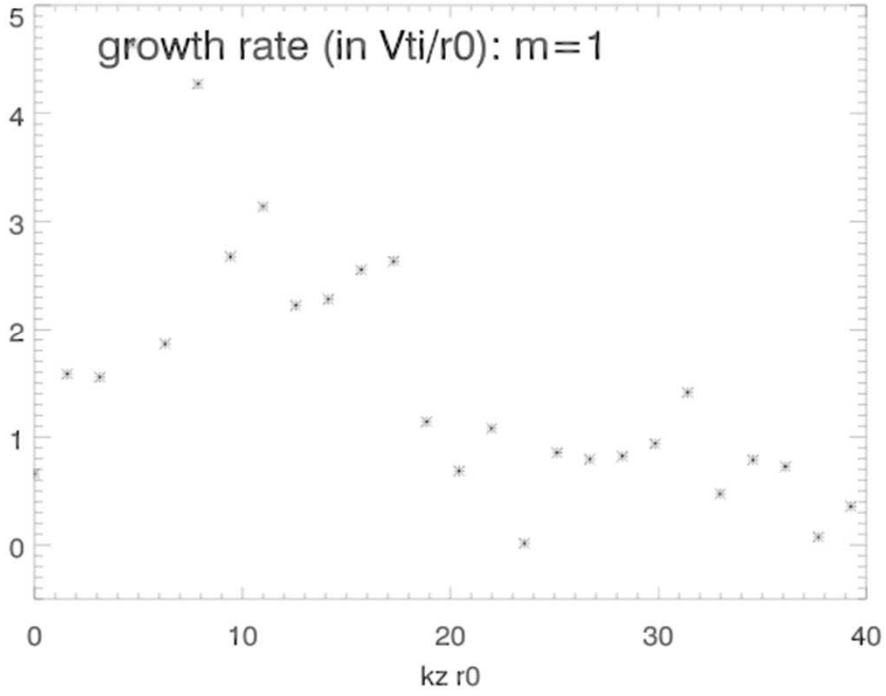
Growth rate for m=0 mode

Light ions density: 99% Heavy ions density: 1%
Light to heavy ion mass ratio: 1/100



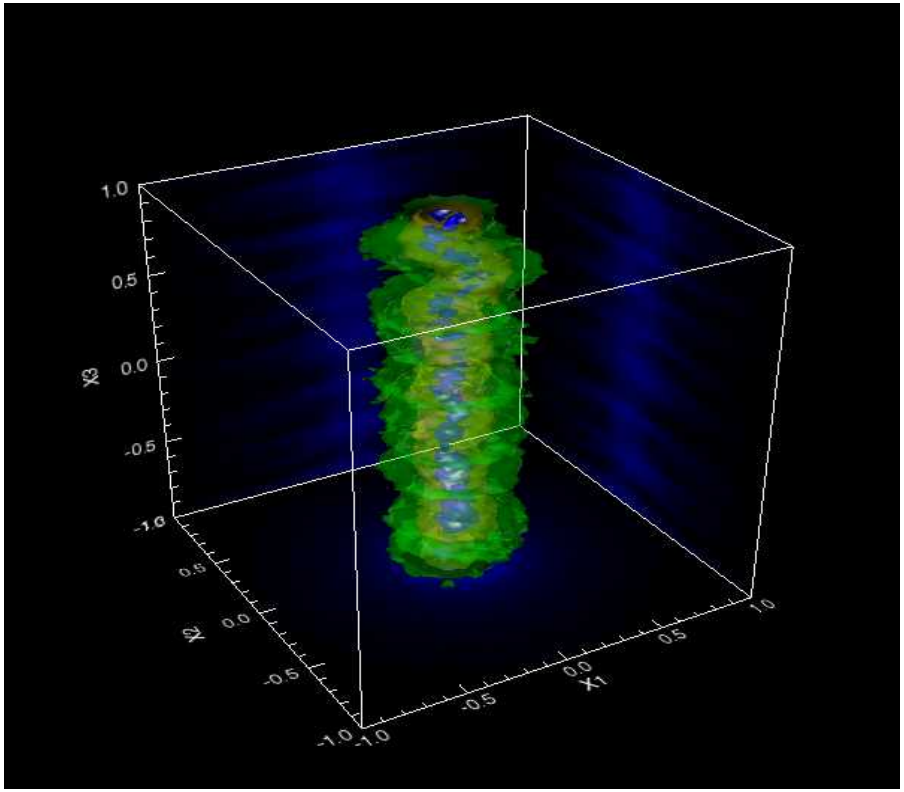
Growth rate for m=1 mode

Light ions density: 99% Heavy ions density: 1%
Light to heavy ion mass ratio: 1/100



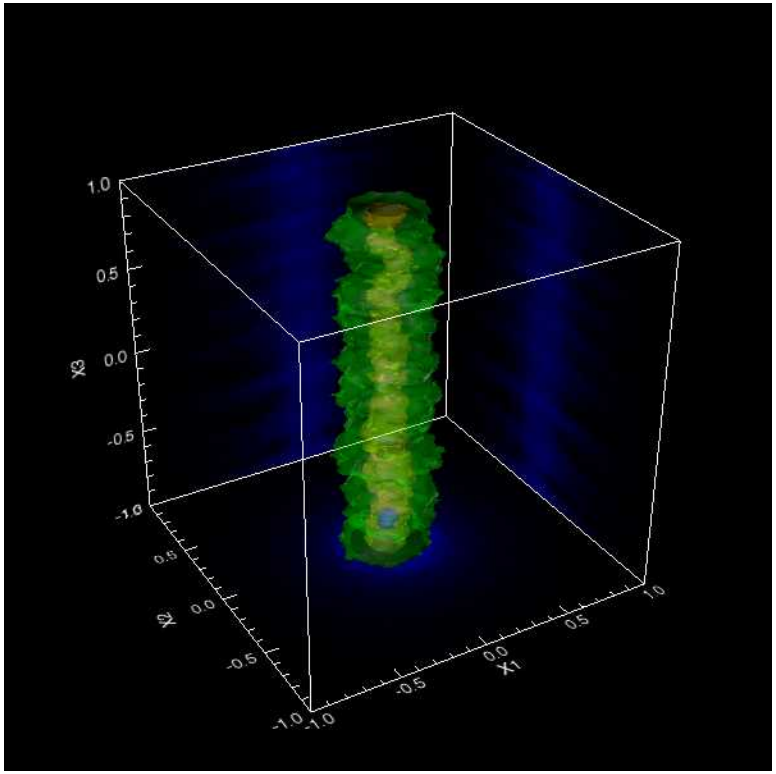
Density of light ions at t = 110

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



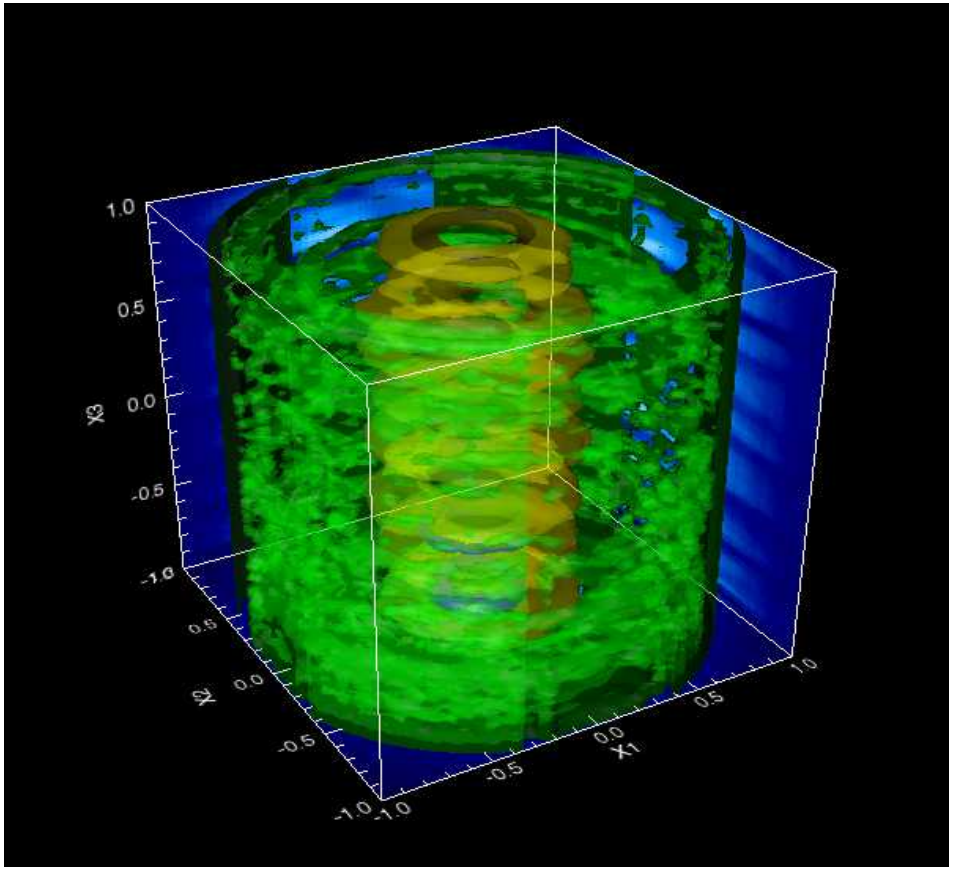
Density of heavy ions at t = 110

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



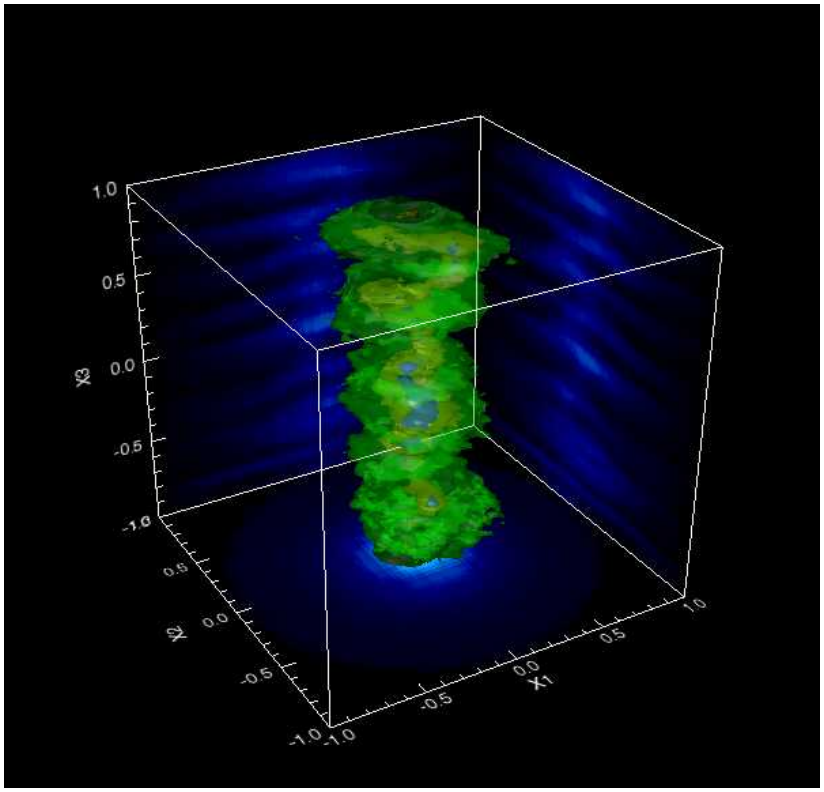
Magnetic field at t = 110

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



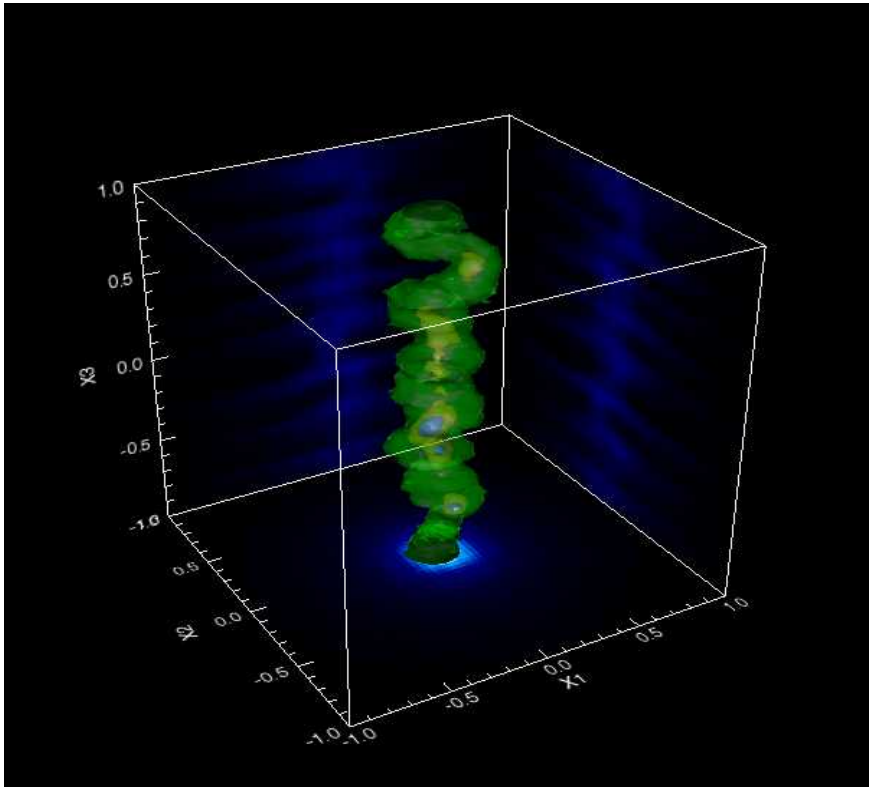
Density of light ions at t = 130

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



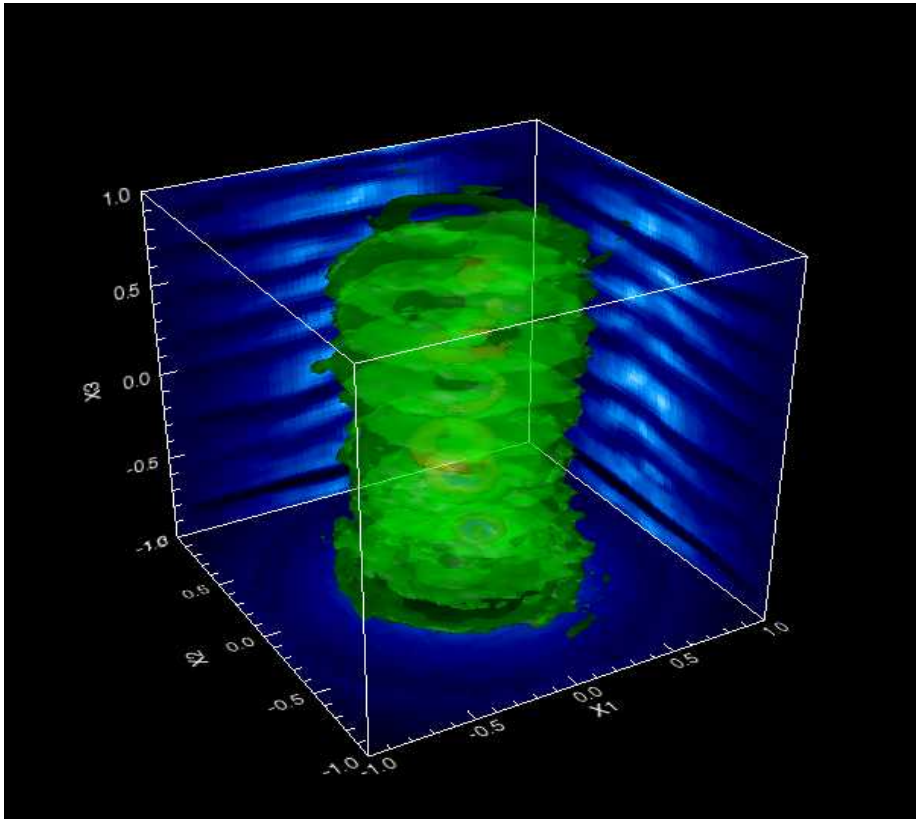
Density of heavy ions at t = 130

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



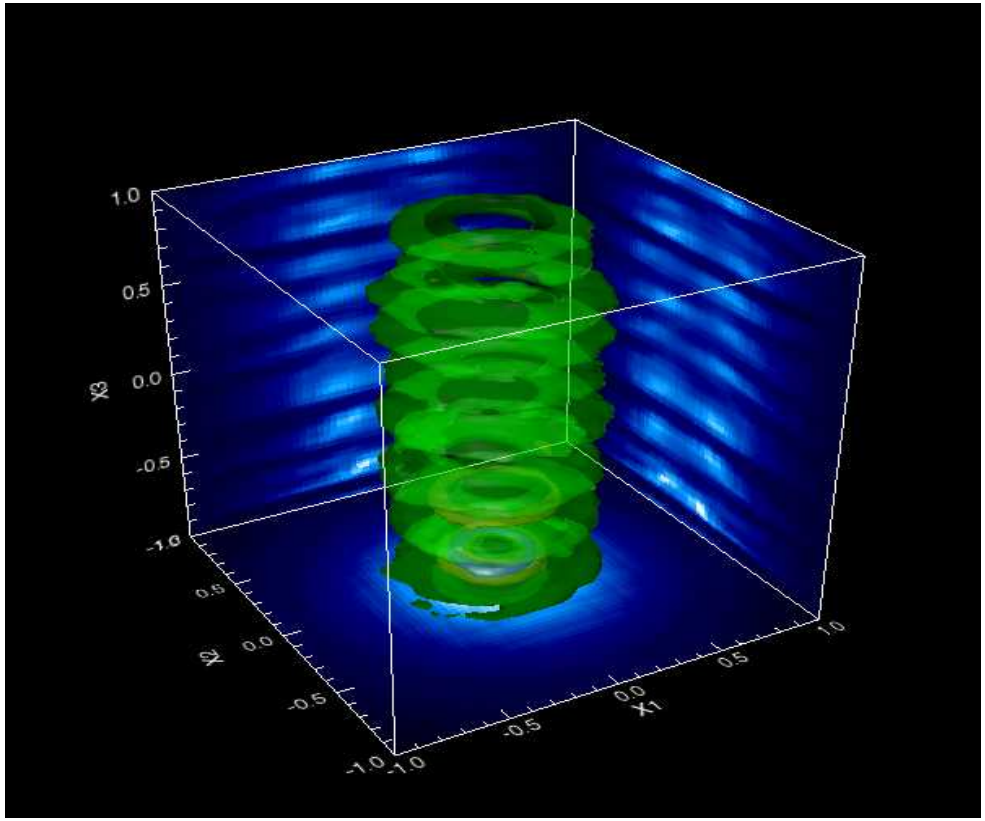
Magnetic field at t = 130

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



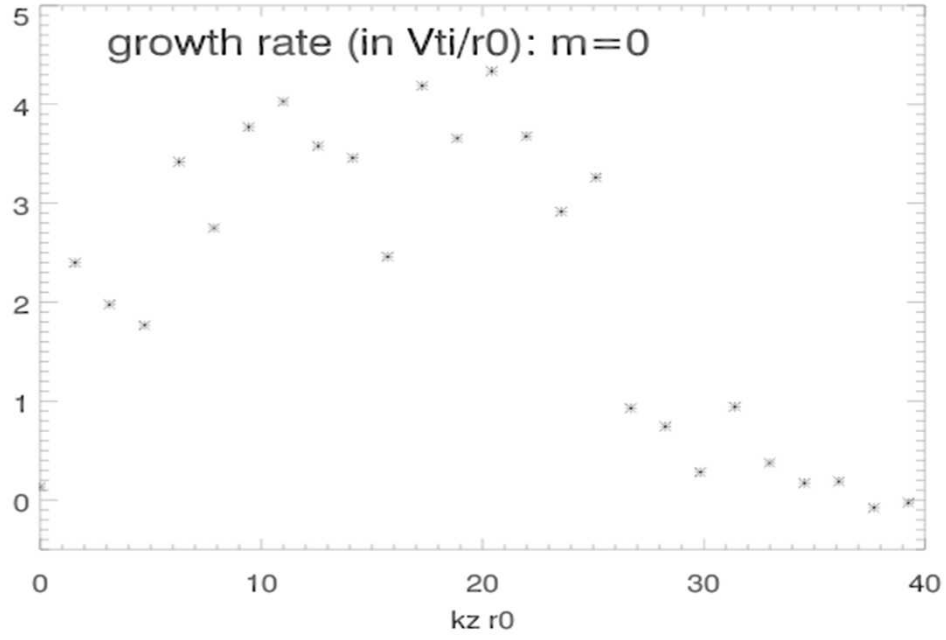
Magnetic field B^2 at t = 110

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



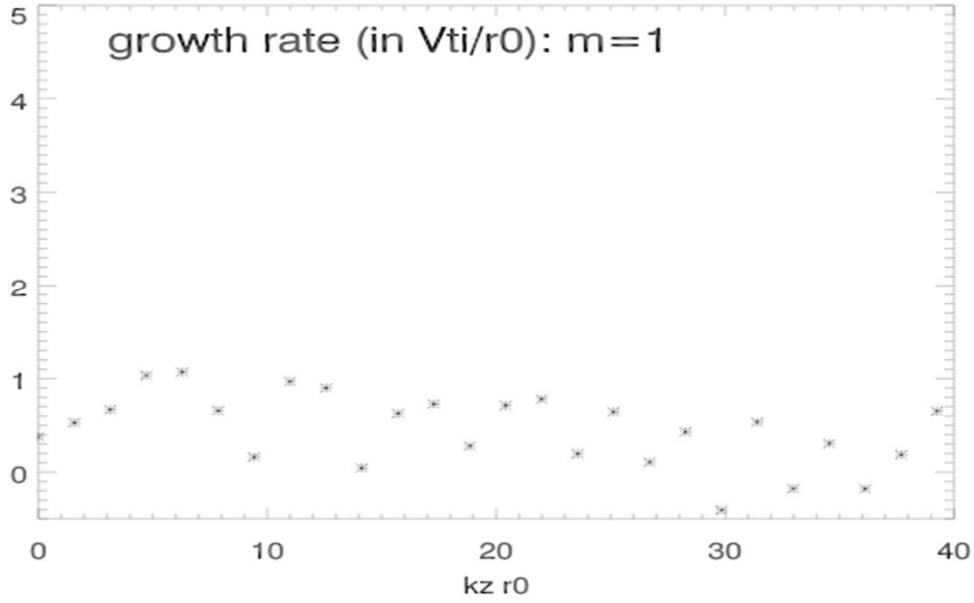
Growth rate for m = 0 mode

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



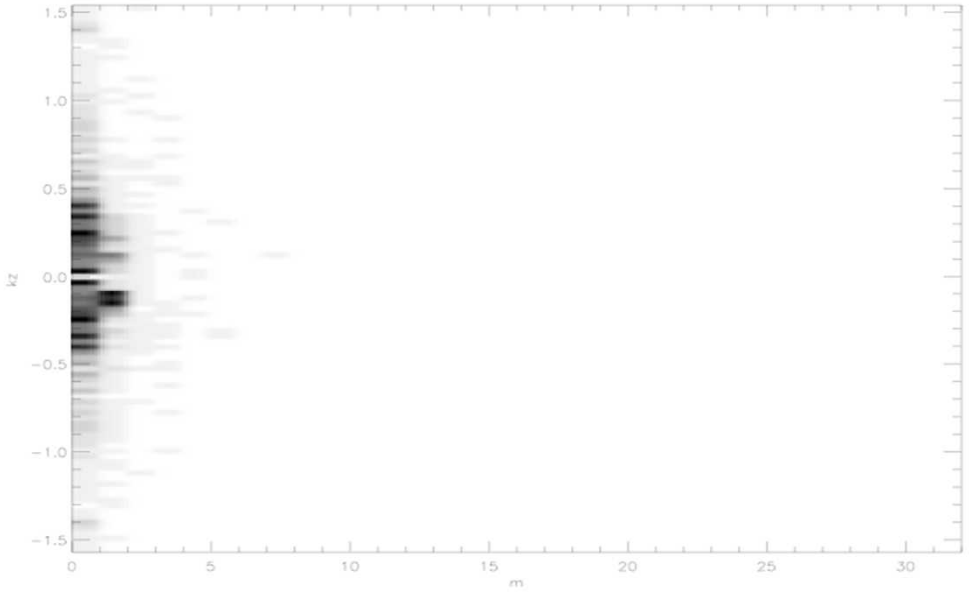
Growth rate for m = 1 mode

Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



Excited wave spectrum

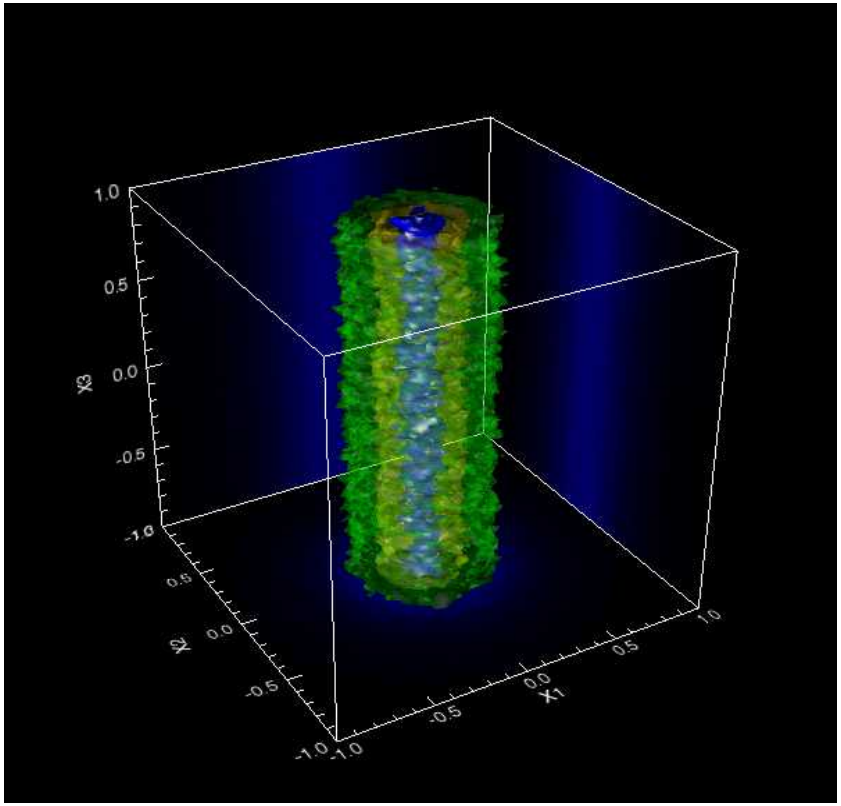
Light ions density: 90% Heavy ions density: 10%
Light to heavy ion mass ratio: 1/100



Density of light ions at t = 100

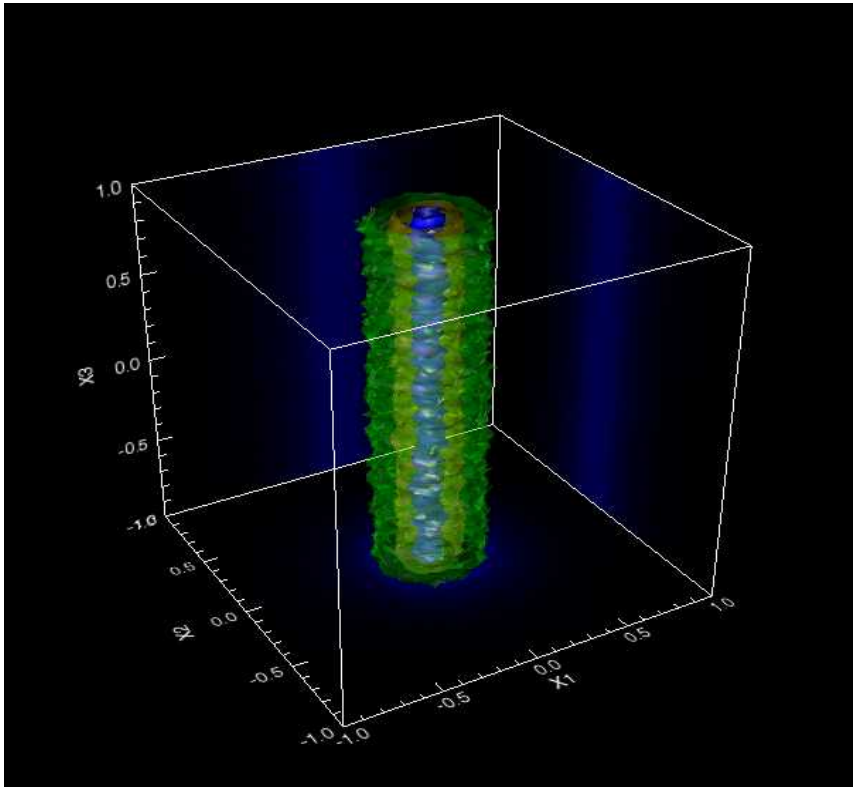
Light ions density: 50% Heavy ions density: 50%

Light to heavy ion mass ratio: 1/100



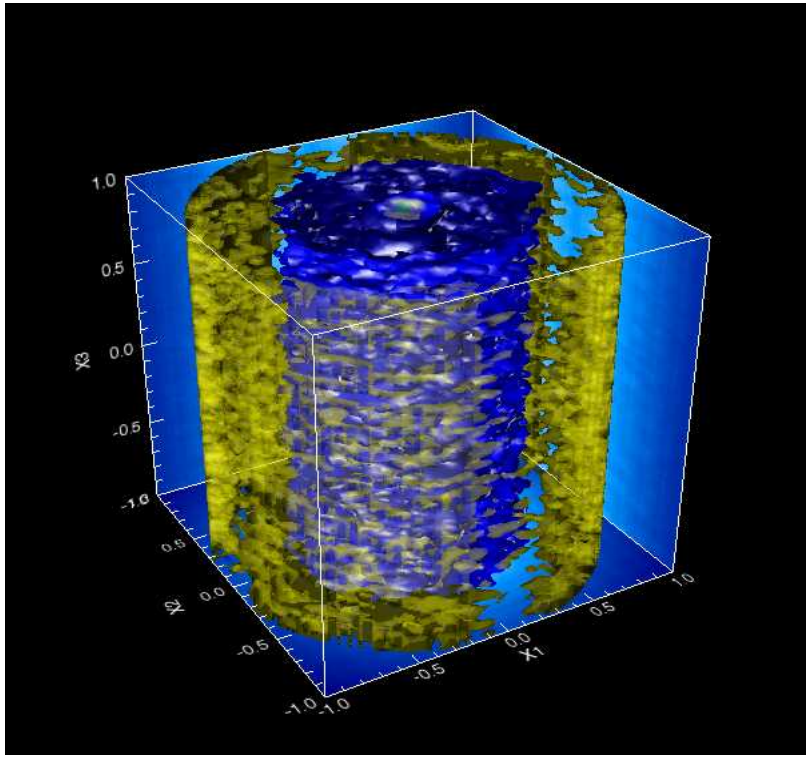
Density of heavy ions at t = 100

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



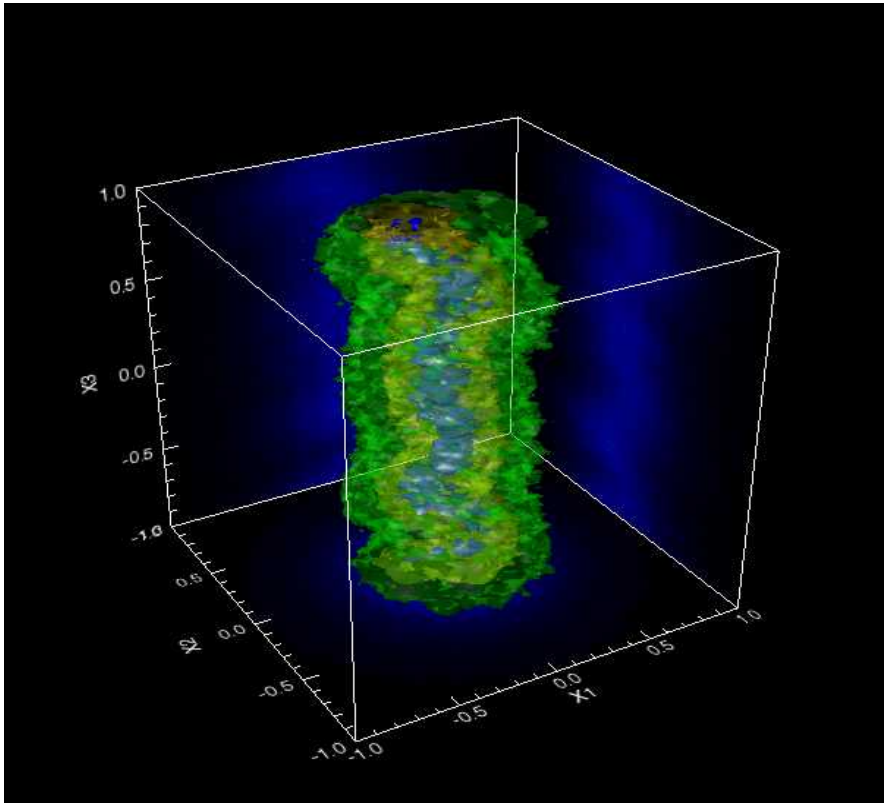
Magnetic field at t = 100

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



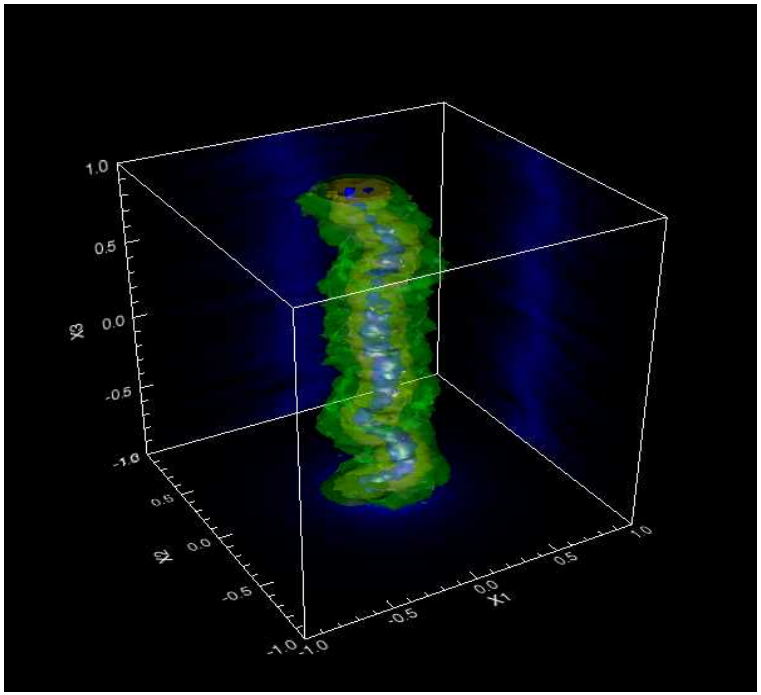
Density of light ions at t = 180

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



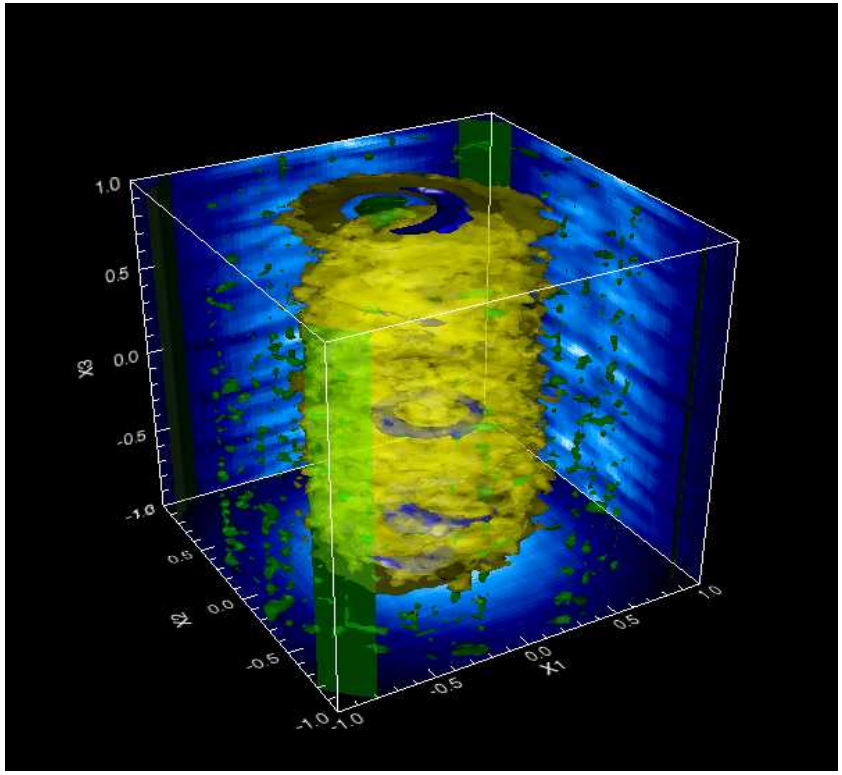
Density of heavy ions at t = 180

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



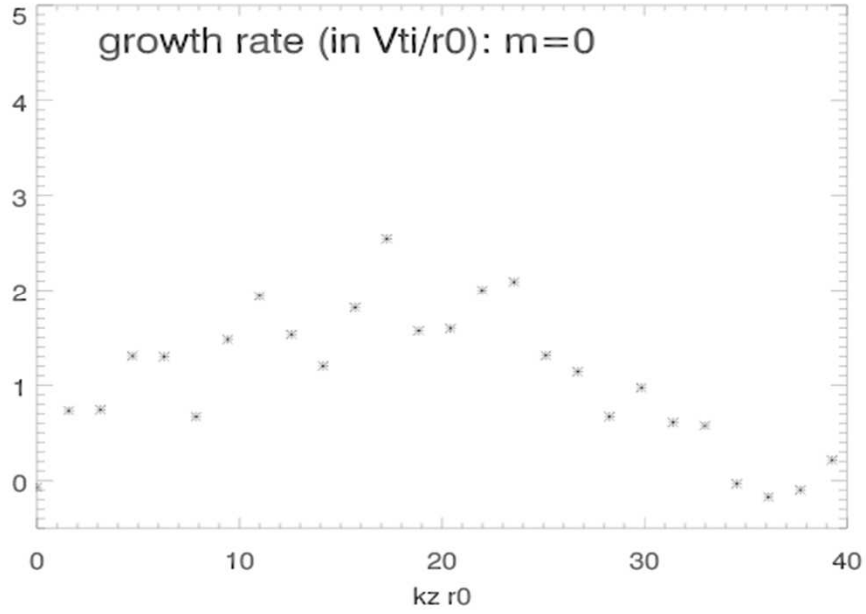
Magnetic field at t = 180

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



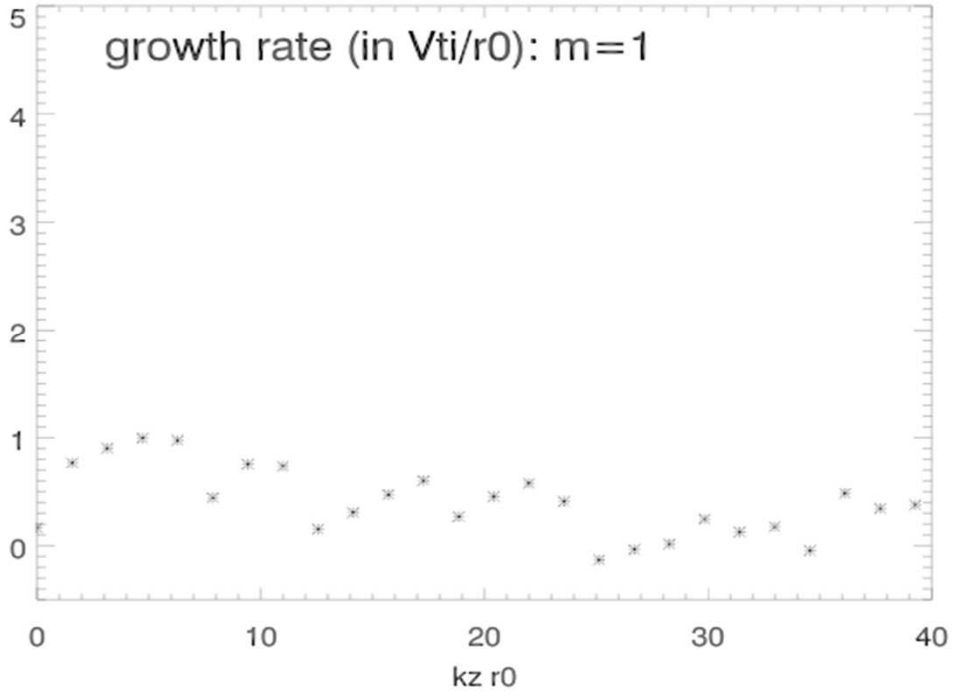
Growth rate of m = 0 mode

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



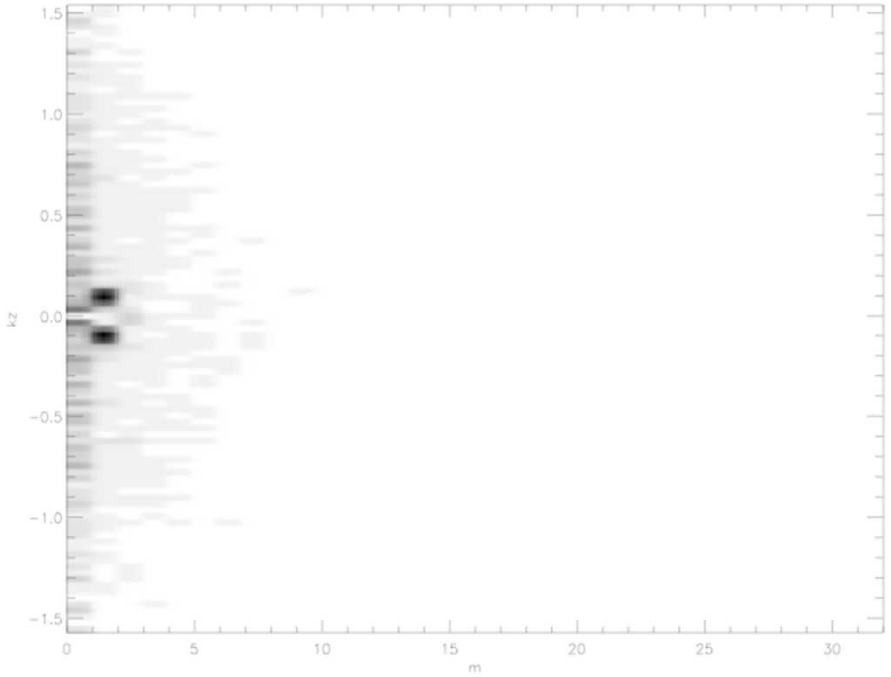
Growth rate of m = 1 mode

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



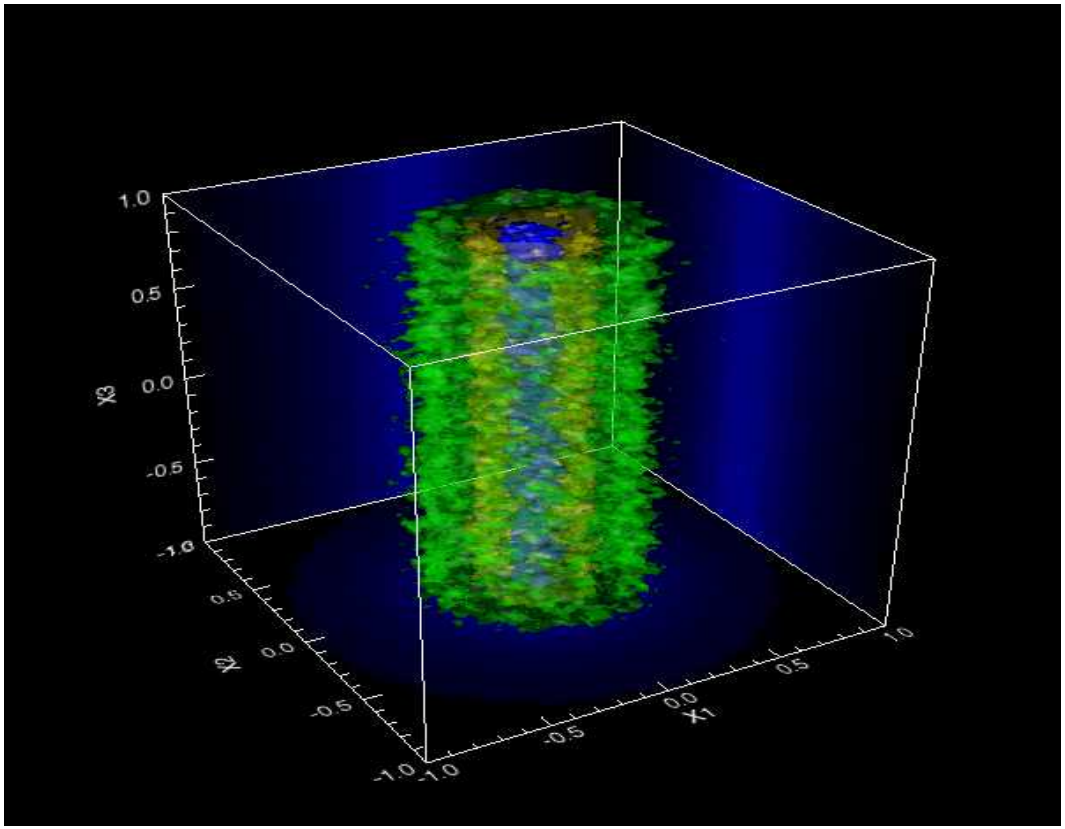
Wave spectrum at t = 100

Light ions density: 50% Heavy ions density: 50%
Light to heavy ion mass ratio: 1/100



Density of light ions at t = 130

Light ions: 10% Heavy ions: 90%



Density of heavy ions at t = 130

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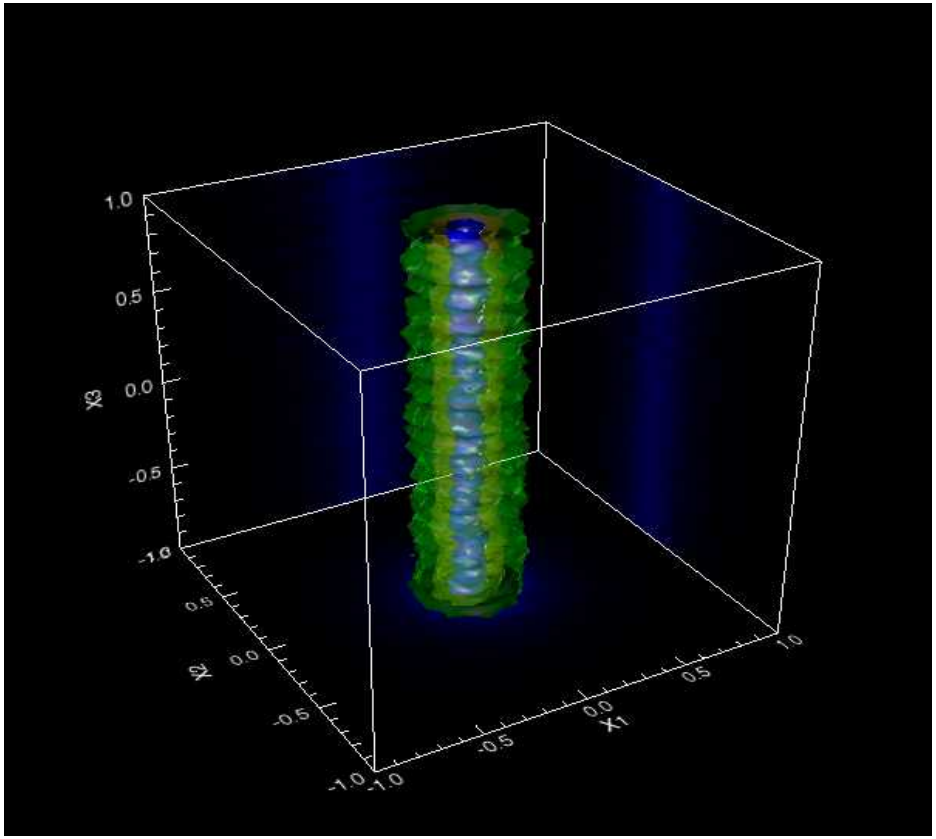

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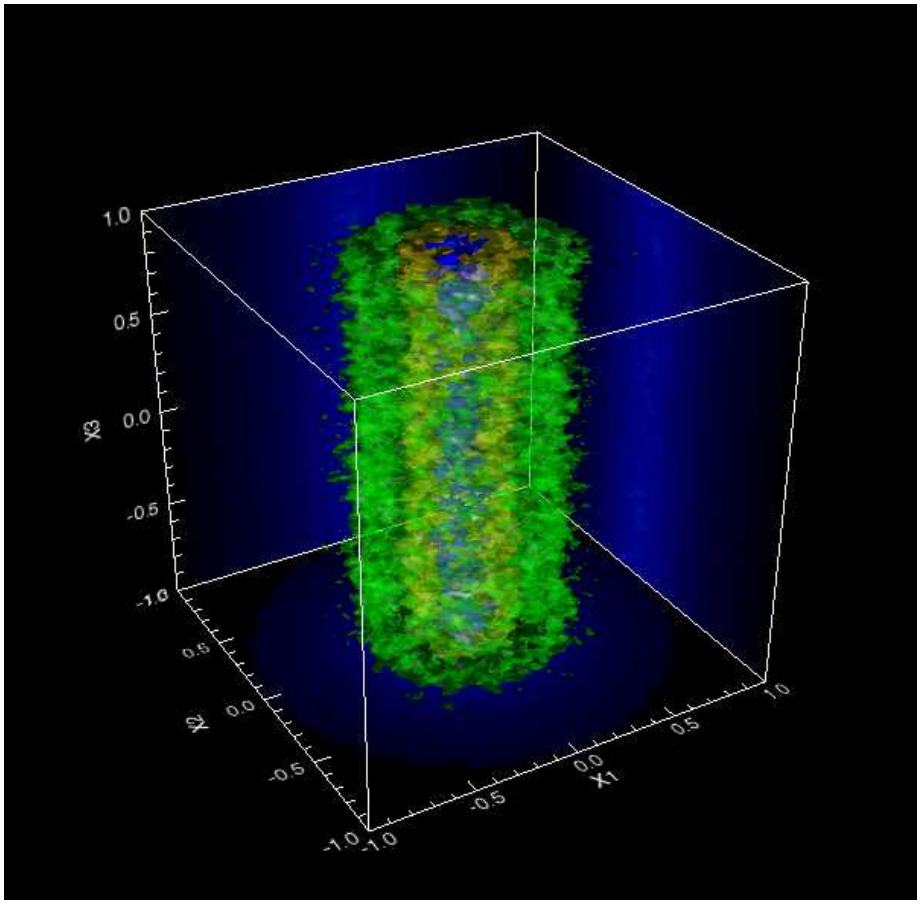
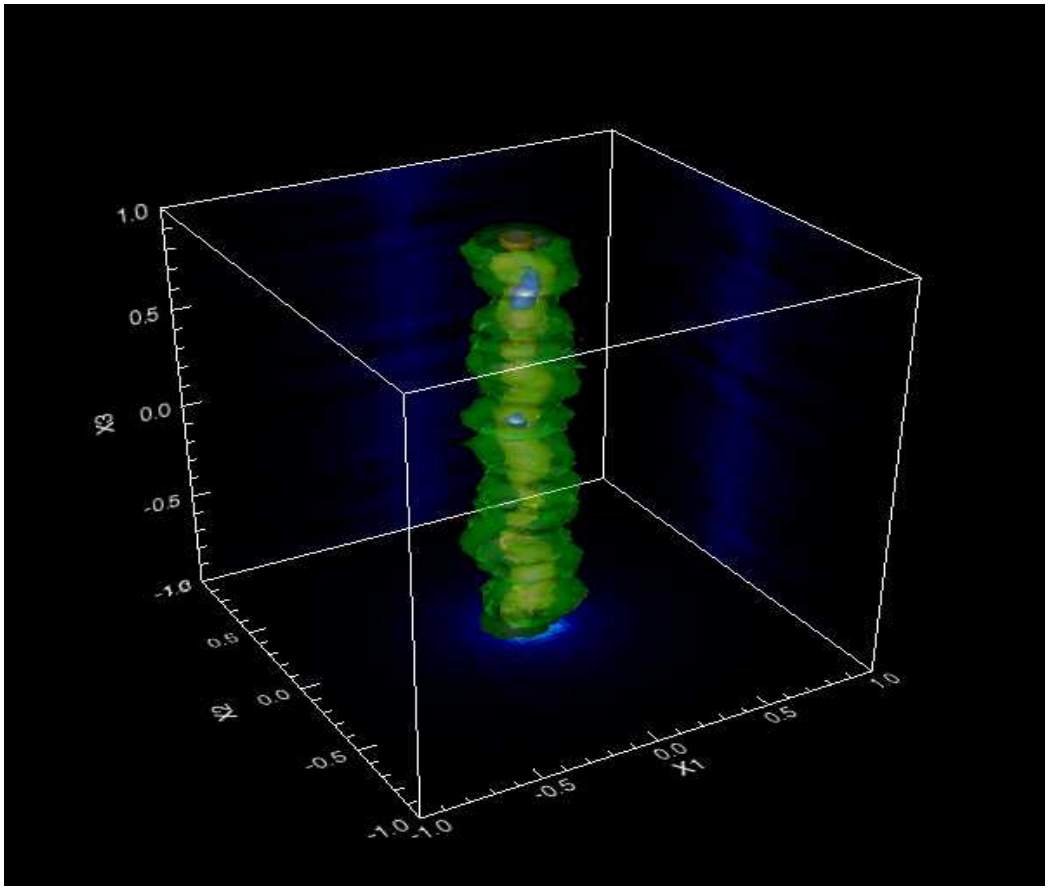


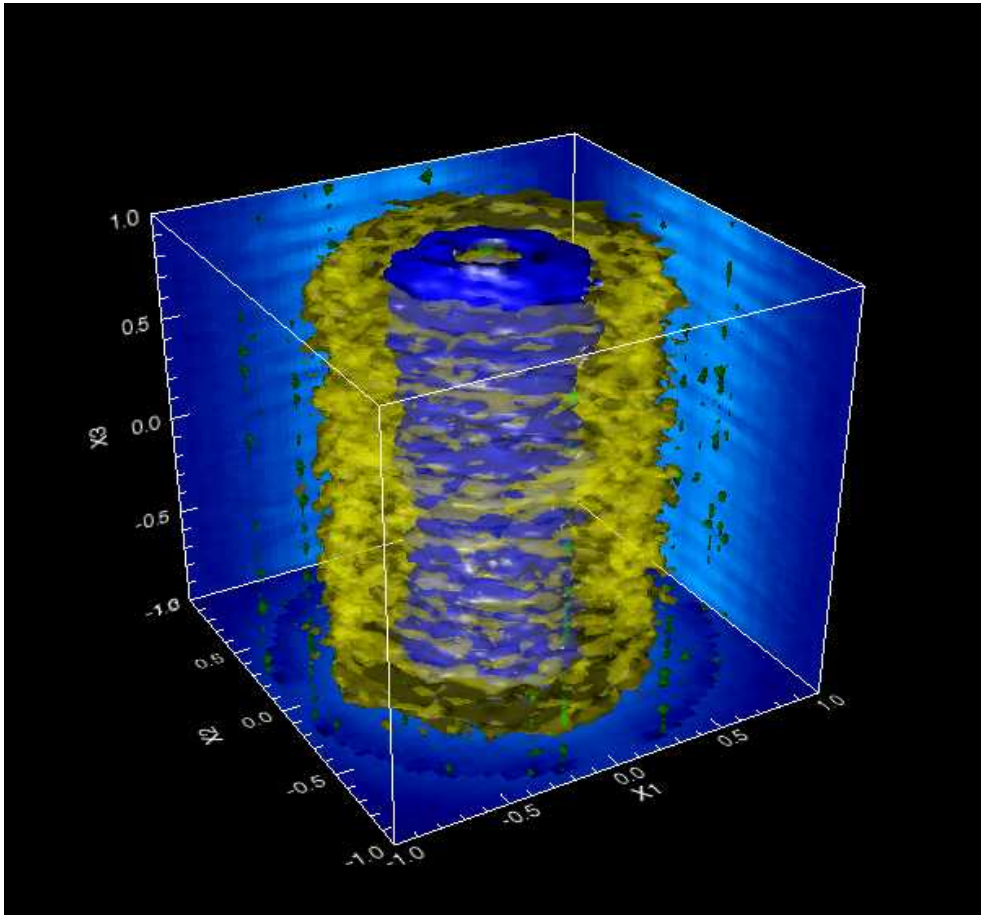
Density of heavy ions at t = 180

Light ions: 10% Heavy ions: 90%



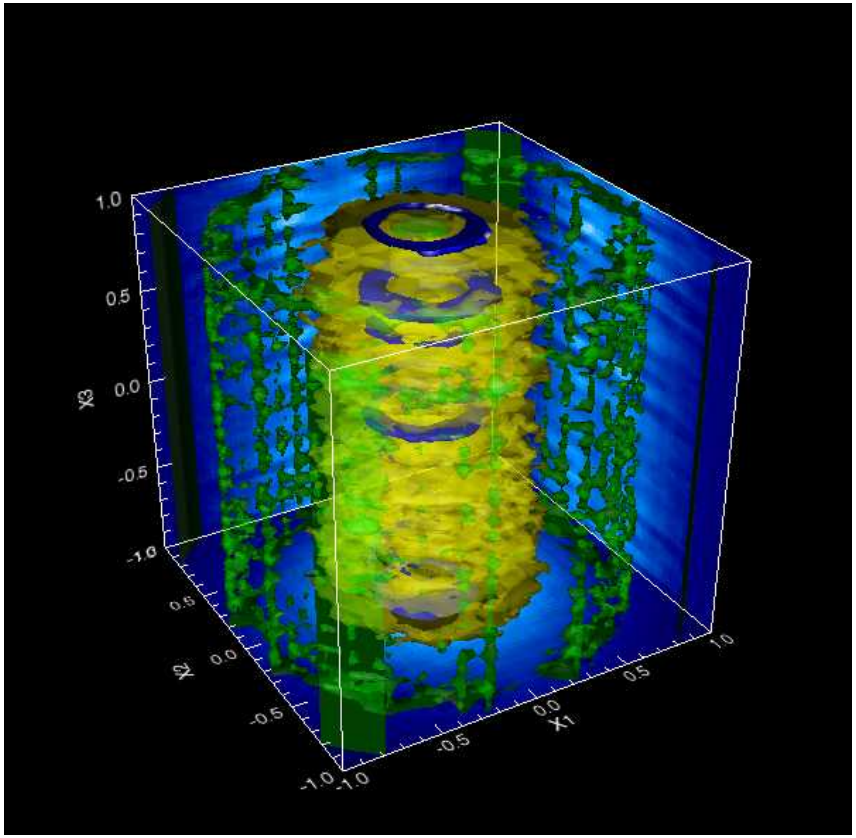
Magnetic field at t = 130

Light ions: 10% Heavy ions: 90%



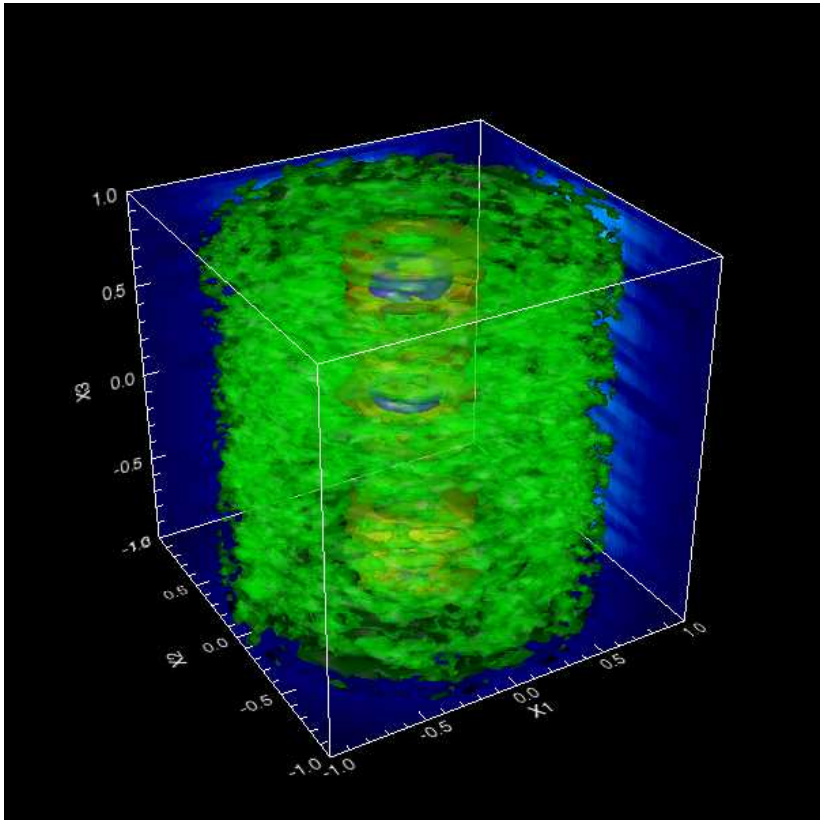
Magnetic field at t = 160

Light ions: 10% Heavy ions: 90%



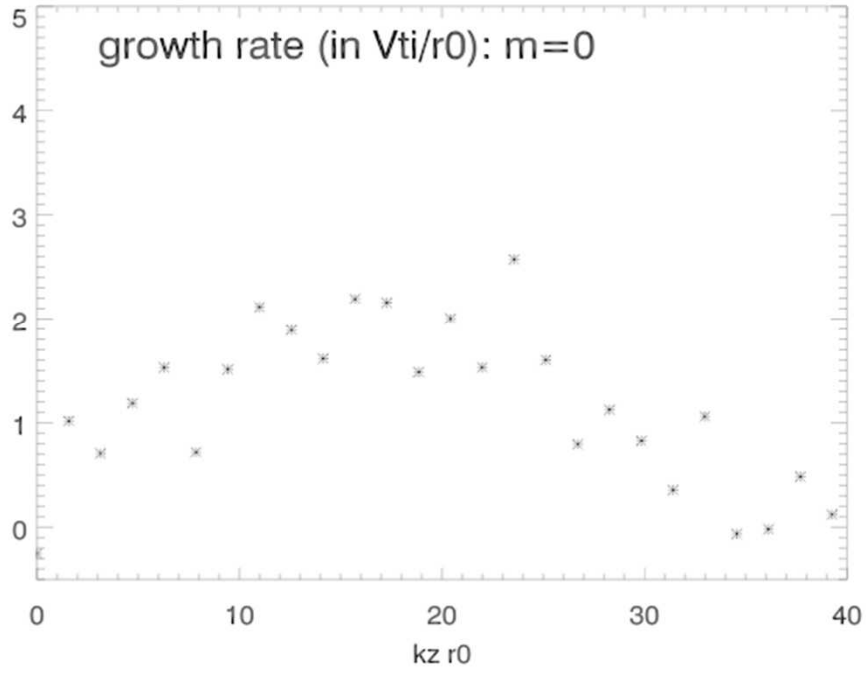
Magnetic field at t = 180

Light ions: 10% Heavy ions: 90%



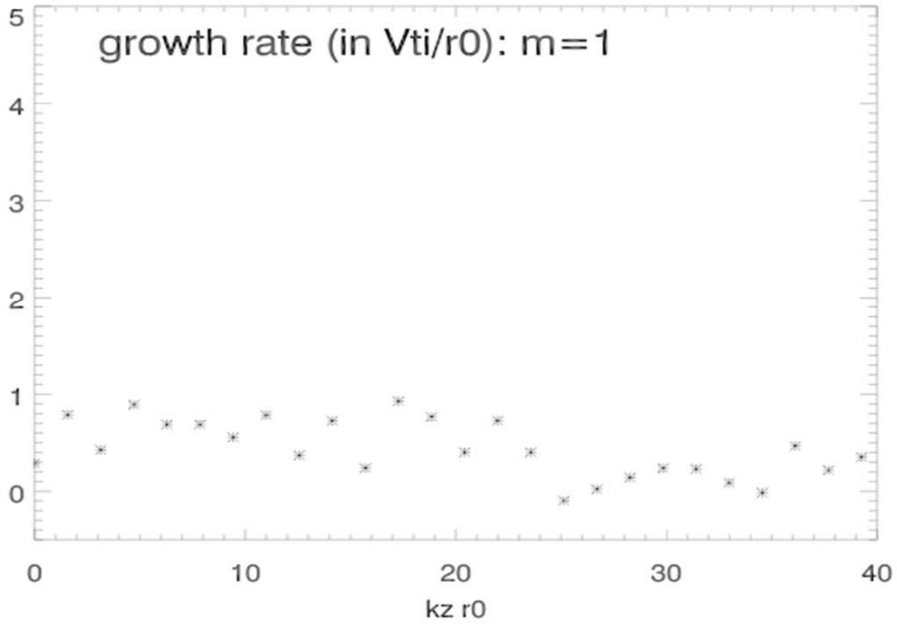
Growth rate of m = 0 mode

Light ions: 10% Heavy ions: 90%



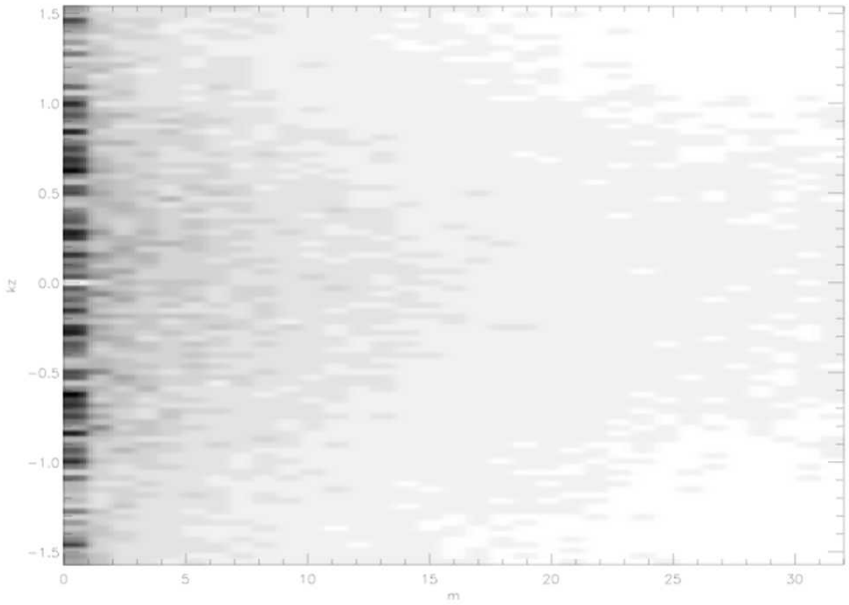
Growth rate of m = 1 mode

Light ions: 10% Heavy ions: 90%



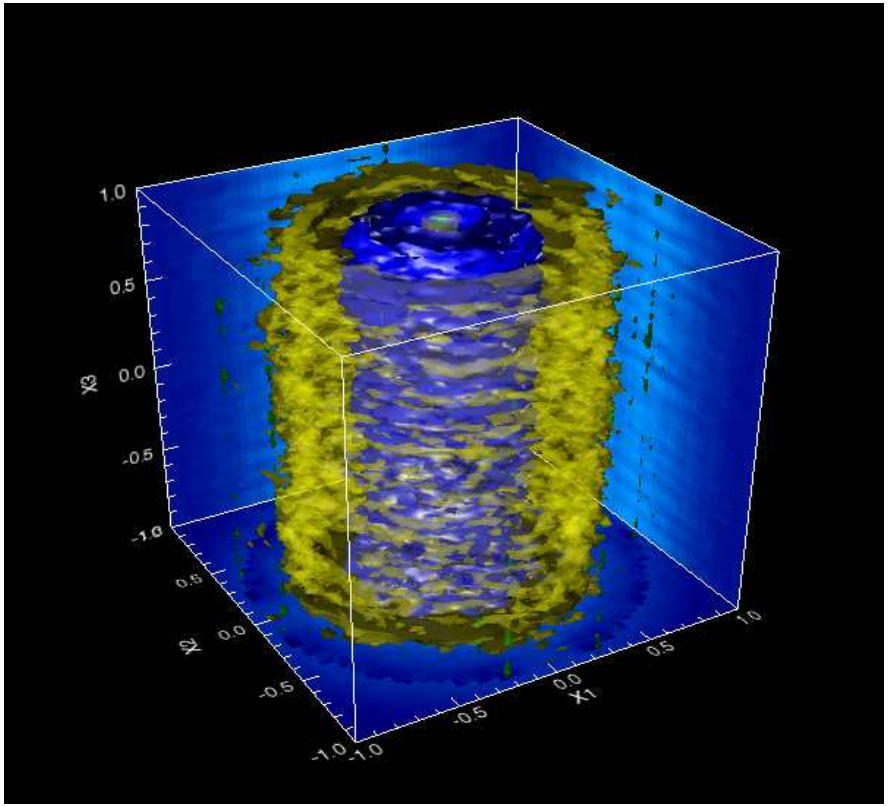
Excited wave spectrum at t = 100

Light ions: 10% Heavy ions: 90%



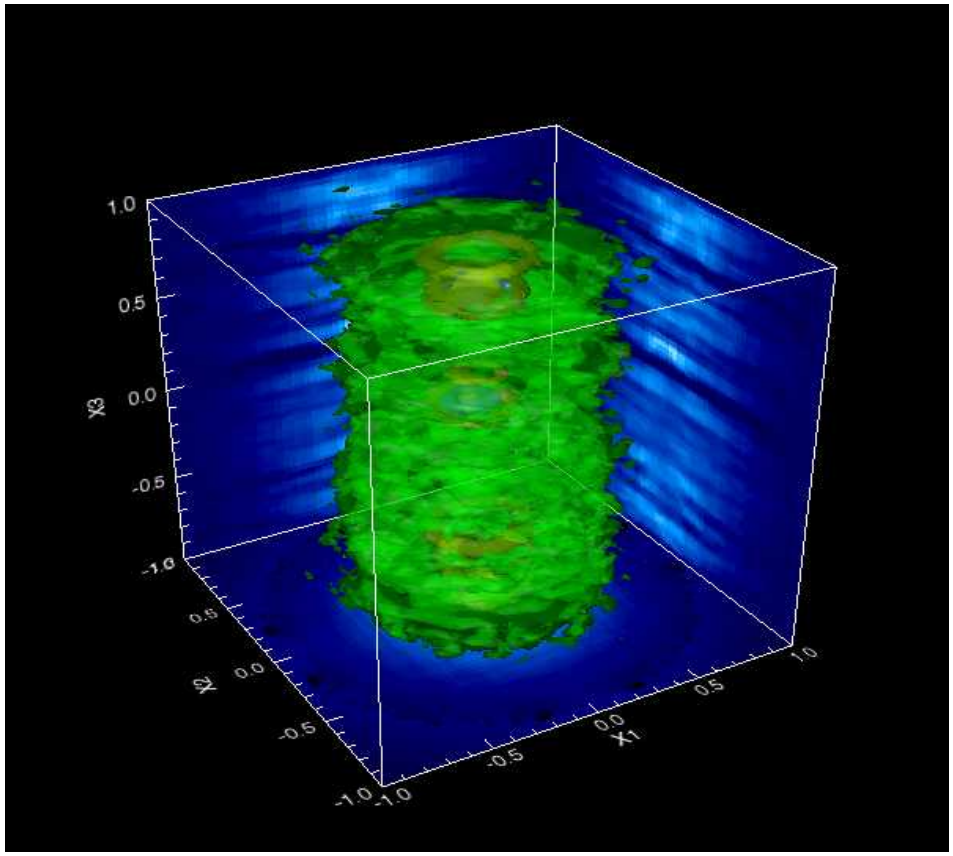
Magnetic field at t = 110

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



Magnetic field at t = 180

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



Density of heavy ions at t = 110

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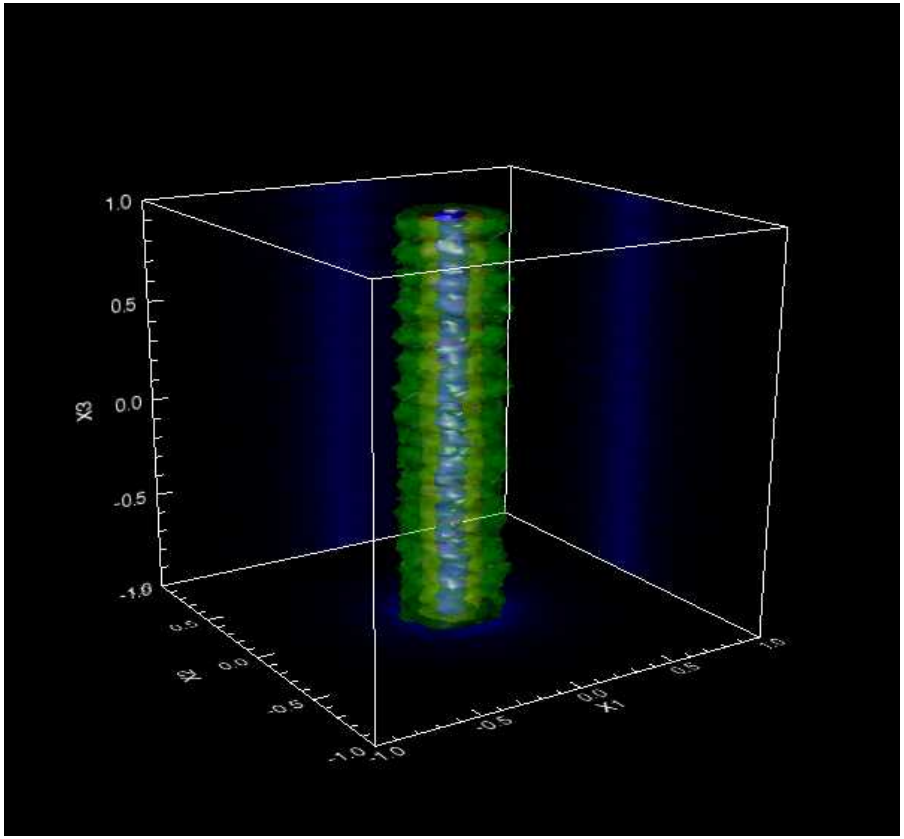
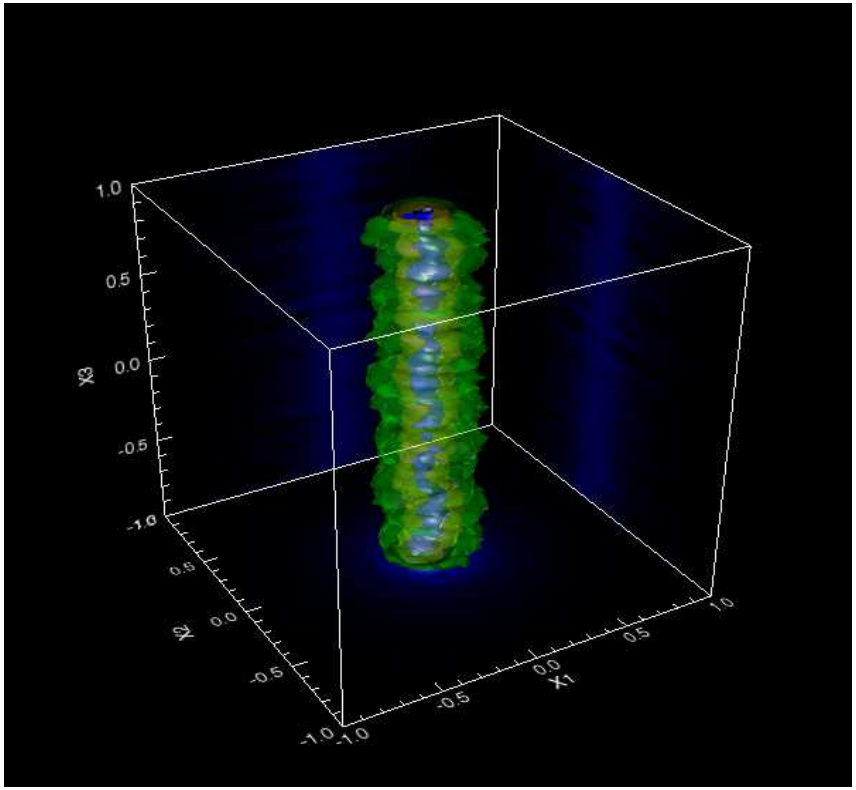
Light to heavy ion mass ratio: 1/100



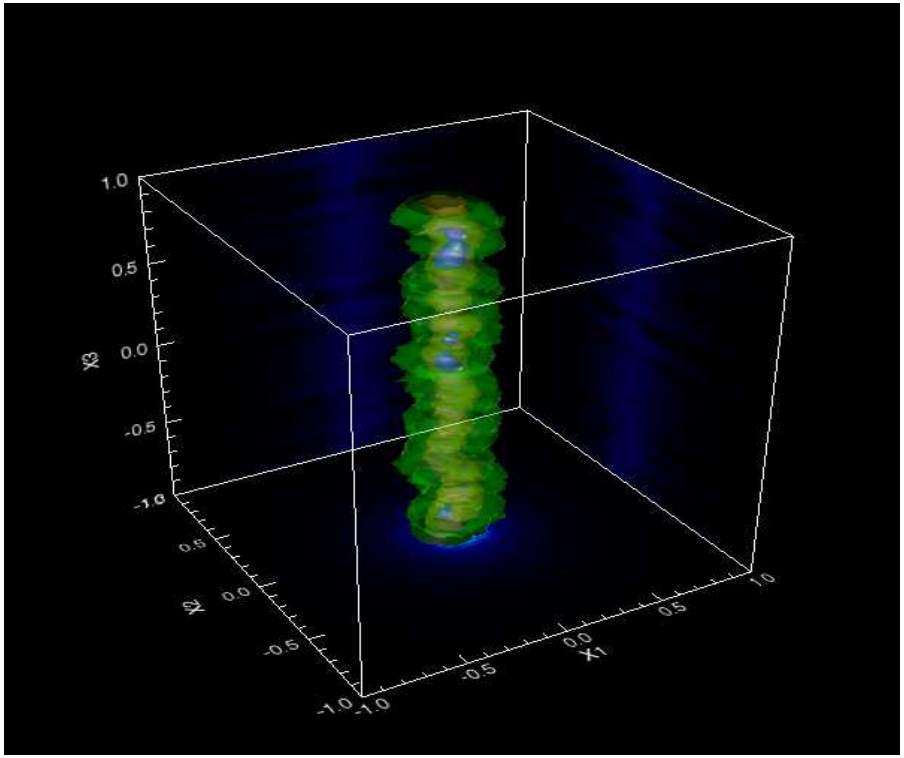
Density of heavy ions at t = 160

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



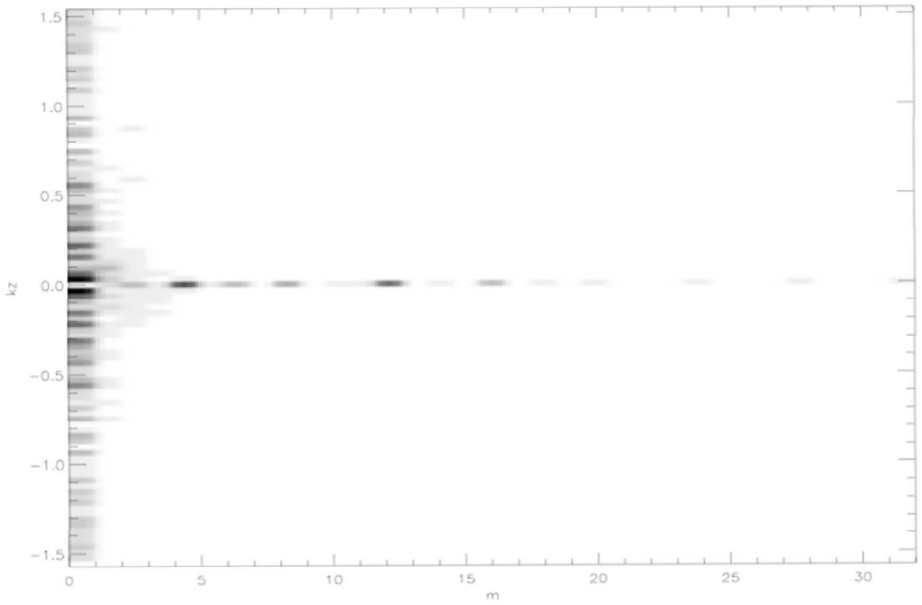
Density of heavy ions at t = 170

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



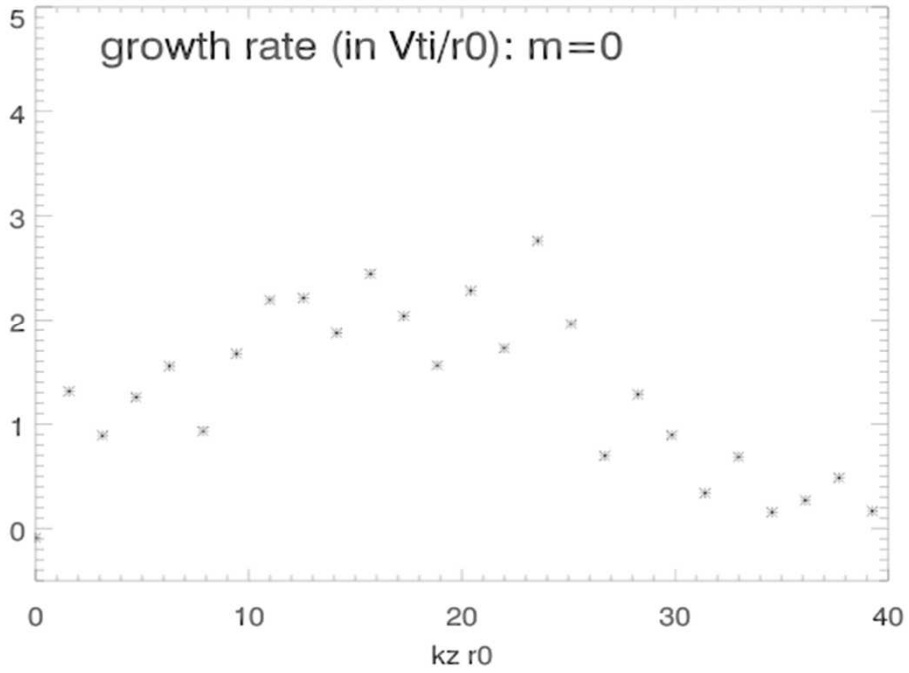
Excited wave spectrum

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



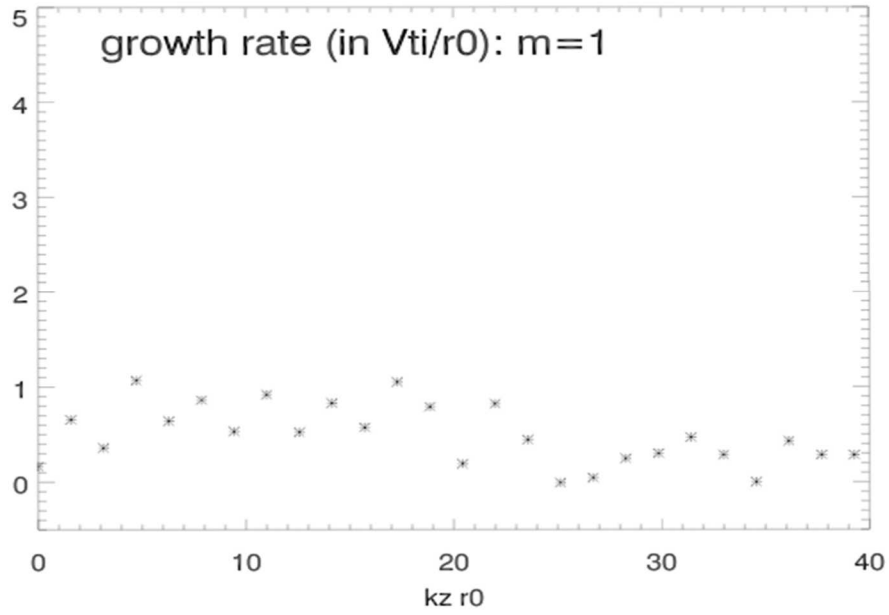
Growth rate of m = 0 mode

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



Growth rate of m = 1 mode

Light ions density: 0% Heavy ions density: 100%
Light to heavy ion mass ratio: 1/100



Conclusions

- Growth rates of sausage and kink instabilities strongly depend on the density ratio of light to heavy ions.
- Growth rates are higher for the larger values of light to heavy ions density ratio.
- Nonideal MHD effects are more pronounced in a plasma with a small density ratio of light to heavy ions.
- Wavelengths of excited waves are shorter for smaller density ratios of light to heavy ions.