My first steps with Ramses: Cooling Halo and fragmenting disc

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1 I'm french (BZH), french mother but english father
First impression

- Easy to compile, just read the Makefile
- Code: Well written and organised in directories.
- Quite straightforward to travel within the code. (usually by grepping in */*.f90)
- Patching is straightforward and easy... (could patch a bug by myself)
- ...if you’re sure to copy the right file into your patch directory

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2 directories mhd/ and hydro/ containing files in with are quite but not totality unlike each other
Cooling halo and fragmenting disk

Running Ramses

3D case: Cooling halo and fragmenting disc

Toying with the polytropic pressure floor

Conclusion
Test: Sedov 2d case
Cooling halo and fragmenting disc

- isolated halo ($v_{200} = 35 \text{km/s}$; $c = 10$; spin = 0.1; $f_{\text{gas}} = 0.15$; $B = 10^{-5}$)
- cooling parameters $[T_{\text{2\,star}}, n_{\text{star}}] = [10^4, 0, 1]$ and default $[z_{\text{ave}}, g_{\text{star}}] = [0., 1.6]$
- coarse grid level 7, max refinement 11
- Box size $\sim 300 \text{kpc}$, resolution $\sim 0.15 \text{kpc}$.
- output at $\sim 5.74 \text{Gyr}$
First result
First result

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Adding solar metallicity $z_{\text{ave}} = 1$ and setting $g_{\text{star}} = 2$
Adding solar metallicity $z_{\text{ave}} = 1$ and setting $\gamma_{\text{star}} = 2$
Net cooling rate for those runs

Net cooling rate \( (\text{erg cm}^2) \)

- \( T^2_{\text{star}}: 1.0 \times 10^4 \)
- \( n_{\text{star}}: 0.1 \)
- \( g_{\text{star}}: 1.6 \)
Net cooling rate for those runs

Net cooling rate (erg cm²)

Conclusion

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The polytropic pressure floor

- Polytropic pressure floor
  \[ T_{\text{min}} = T_{2\text{star}} \times (n_H/n_{\text{star}})^{g_{\text{star}}-1} \]
The polytropic pressure floor

- **Polytropic pressure floor**
  \[ T_{\text{min}} = T_{2\text{star}} \ast (n_H/n_{\text{star}})^{g_{\text{star}}-1} \]

- **Minimum Jeans Length for gravitational collapse**
  \[ \Lambda_J = c \ast \tau_{ff} \]
  with \( c = \sqrt{P/\rho} = \sqrt{k_B T/m_H} \) and 
  \( \tau_{ff} = \sqrt{\pi/G\rho} = \sqrt{\pi/Gm_H \ast n_H} \)

- Conclusion
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  with \( g_{\text{star}} = 2 \) we get \( \Lambda_{J} = \sqrt{k_{B}\pi/Gm_{H}^{2}} \times \sqrt{T^{2}_{\text{star}}/n_{\text{star}}} \)
The polytropic pressure floor

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- **Well..**
  \[ \Lambda_J = \sqrt{k_B \pi / G m_H^2} \times \sqrt{T_{\text{min}} / n_H} \]
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  with \( g_{\text{star}} = 2 \) we get \( \Lambda_J = \sqrt{k_B \pi / G m_H^2} \times \sqrt{T_{2\text{star}} / n_{\text{star}}} \)

- **To prevent artificial fragmentation** \( \Lambda_J > 4 \Delta x \)
Decreasing the Pressure floor

Net cooling rate (erg cm$^2$)

$T_{\star}^2$: 1.E+04 $n_{\star}$: 0.1 $g_{\star}$: 2.0

Log T (K)

Log $n_a$ (cm$^{-3}$)
Decreasing the Pressure floor

Net cooling rate (erg cm²)

Log T (K)

Log n (cm⁻³)

T²_{star}: 5.0 10^3 n_{star}: 0.1 g_{star}: 2.0
Decreasing the Pressure floor

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**Cooling halo and fragmenting disk**

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**Conclusion**

![Image of a graph showing net cooling rate in erg cm$^{-2}$ vs. log of temperature and log of density, with annotations for $T_{star}$, $n_{star}$, and $g_{star}$ values.](image-url)
$T_{2 \text{star}} = 10000, n_{\text{star}} = 0.1, \Lambda_J = 33.98\Delta x$
\[ T^2_{\text{star}} = 10000, \quad n_{\text{star}} = 0.1, \quad \Lambda_J = 33.98 \Delta x \]
$T_{2\text{star}} = 5000, n_{\text{star}} = 0.1, \Lambda_J = 24.03 \Delta x$
$T^2_{\text{star}} = 5000, \ n_{\text{star}} = 0.1, \ \Lambda_J = 24.03 \Delta x$

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$T_{2,\text{star}} = 1000$, $n_{\text{star}} = 0.1$, $\Lambda_J = 10.75\Delta x$
$T_{2\text{star}} = 1000$, $n_{\text{star}} = 0.1$, $\Lambda J = 10.75\Delta x$
\[ T_{2\text{star}} = 300, \quad n_{\text{star}} = 0.1, \quad \Lambda_J = 5.89 \Delta x \]
$T_{2\text{star}} = 300, n_{\text{star}} = 0.1, \Lambda_J = 5.89\Delta x$
Conclusion

- Learned how to send a job using PBS script.
- got much much familiar with Ramses
- got an idea, of the work involved in getting accurate physics from a simulation
- created my own visualisation routines from the one provided. (learned new good tricks with idl)
- was happy to share the little experience I had with others running the same project.