Chemistry and the X_{CO} conversion factor

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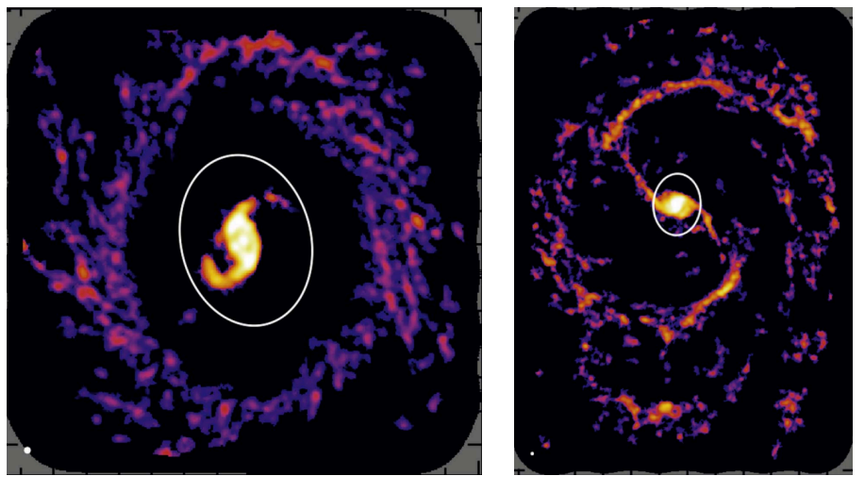
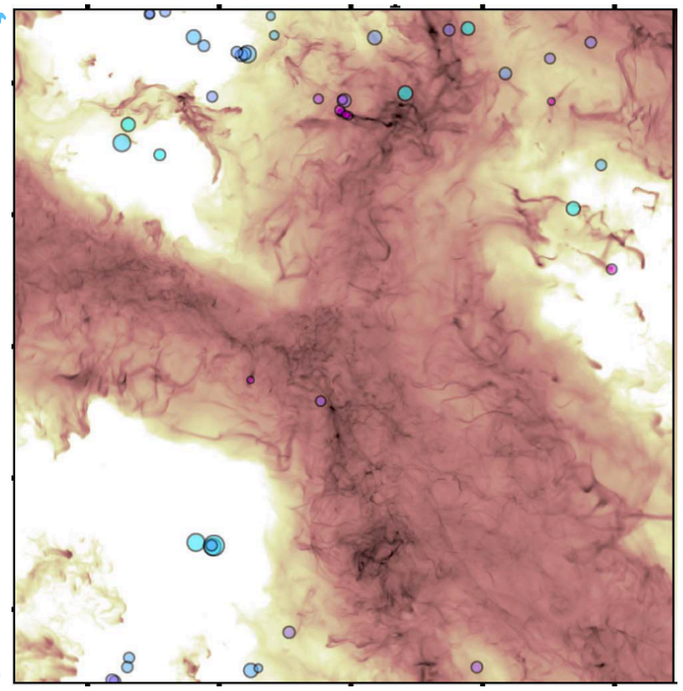
Athena++ workshop, UNLV, March 2019
With Eve Ostriker and Chang-Goo Kim (Princeton)

Motivation

chemistry



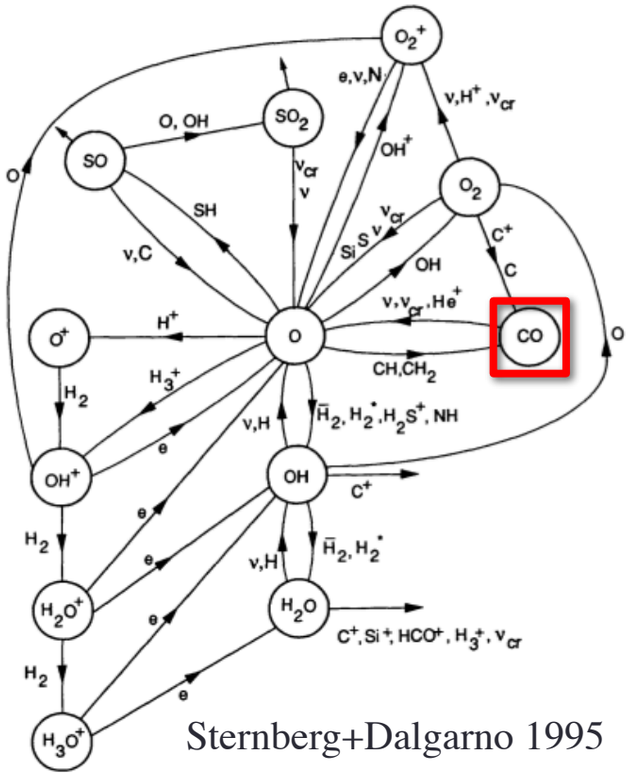


CO (2-1) line luminosities, from Sun+ (2018), PHANGS project

Column densities, from Kim+Ostriker (2017), TIGRESS simulations

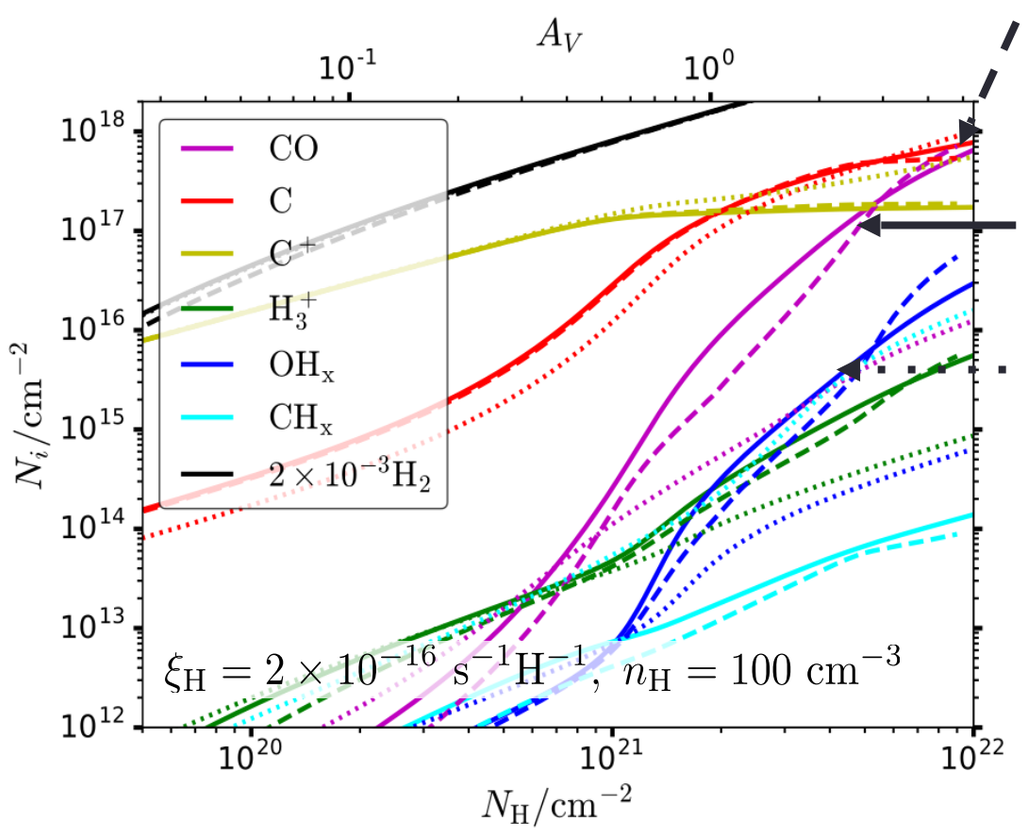
Chemical Network

- What network?



Sternberg+Dalgarno 1995

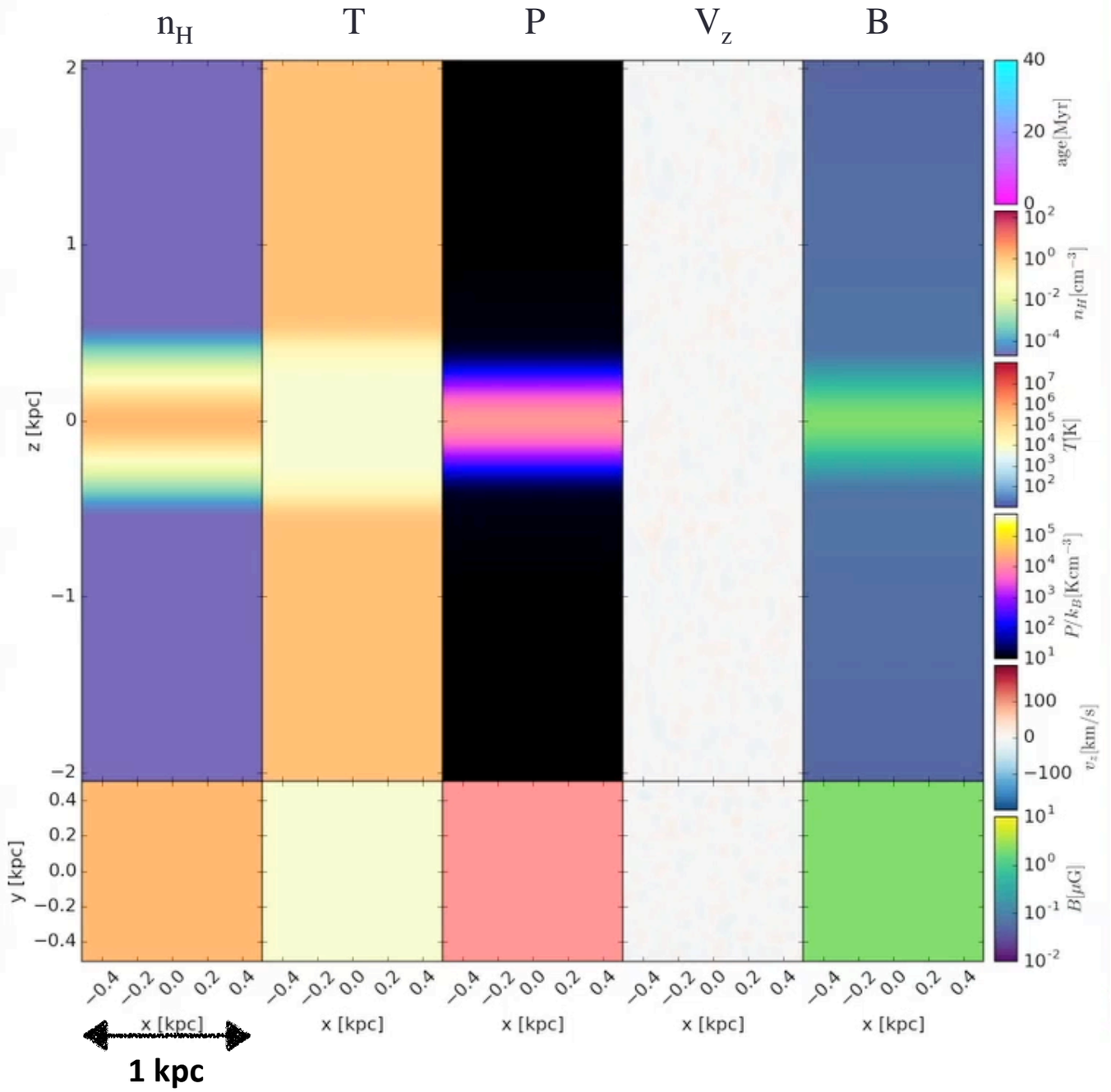
FIG. 2.—Oxygen network



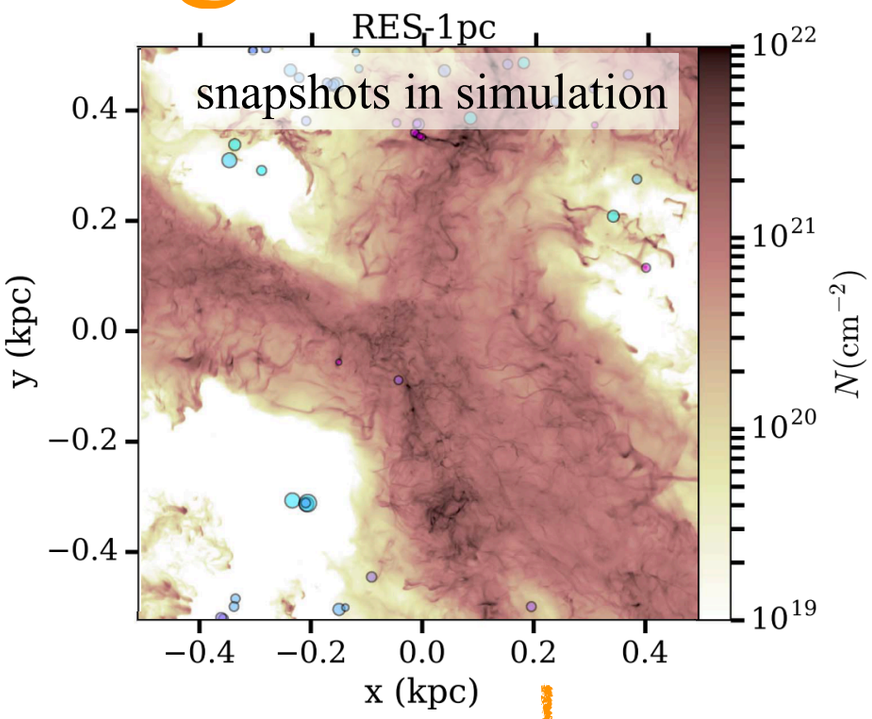
- PDR code: ~50 species, ~500 reactions
  the "right answer"
- Our network: ~20 species, ~50 reactions
- Nelson+Langer (1999) network

Gong, Ostriker and Wolfire (2017), ApJ, 843:38
A Simple and Accurate Network for Hydrogen and Carbon Chemistry in the ISM

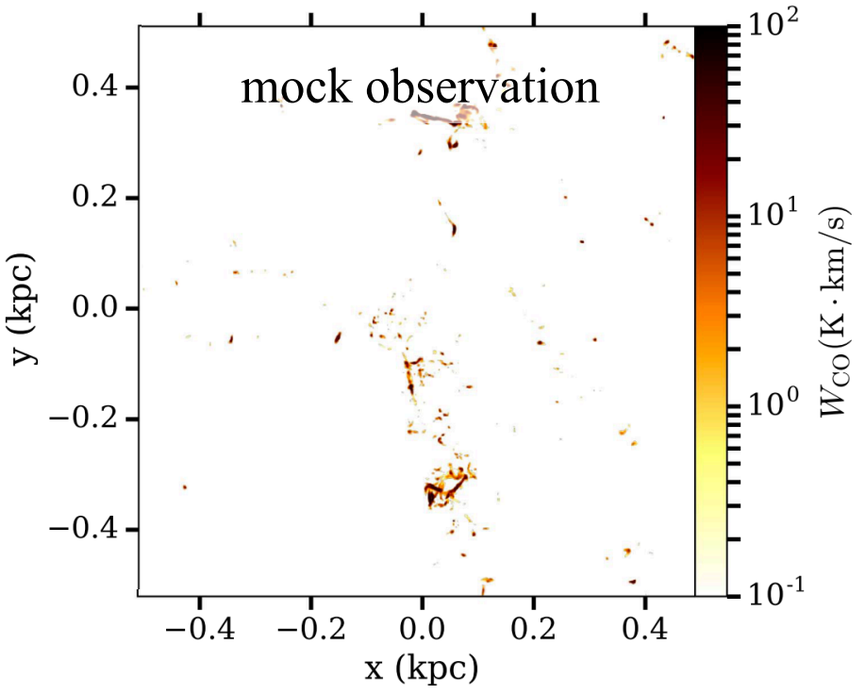
Simulating the Solar Neighbourhood



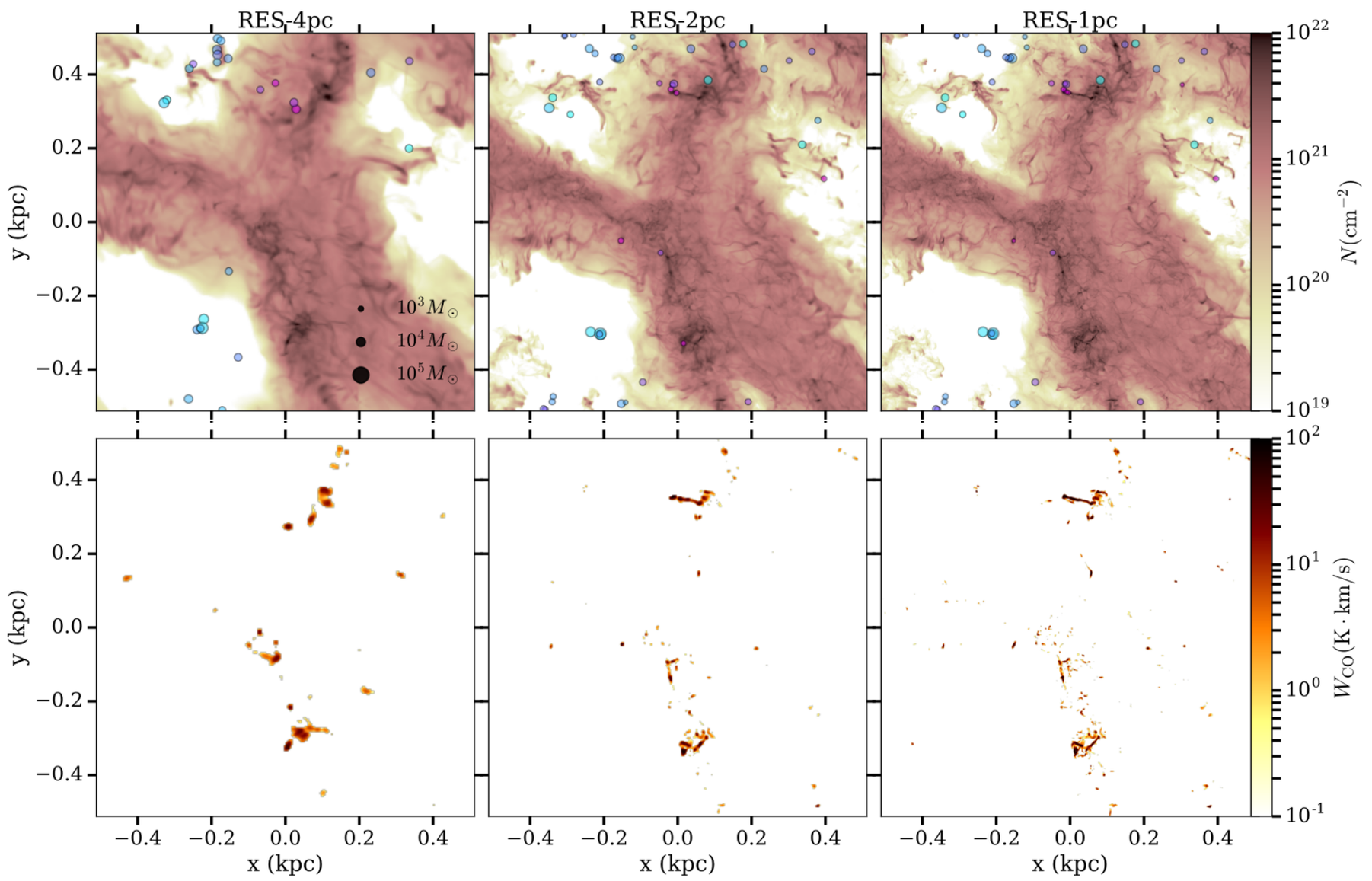
Kim+Ostriker (2017), movie by Chang-Goo Kim
TIGRESS simulations: 3-phase ISM, self-consistent star formation with supernova feedback.



chemistry
+
radiation transfer



Caution: the Resolution Effect

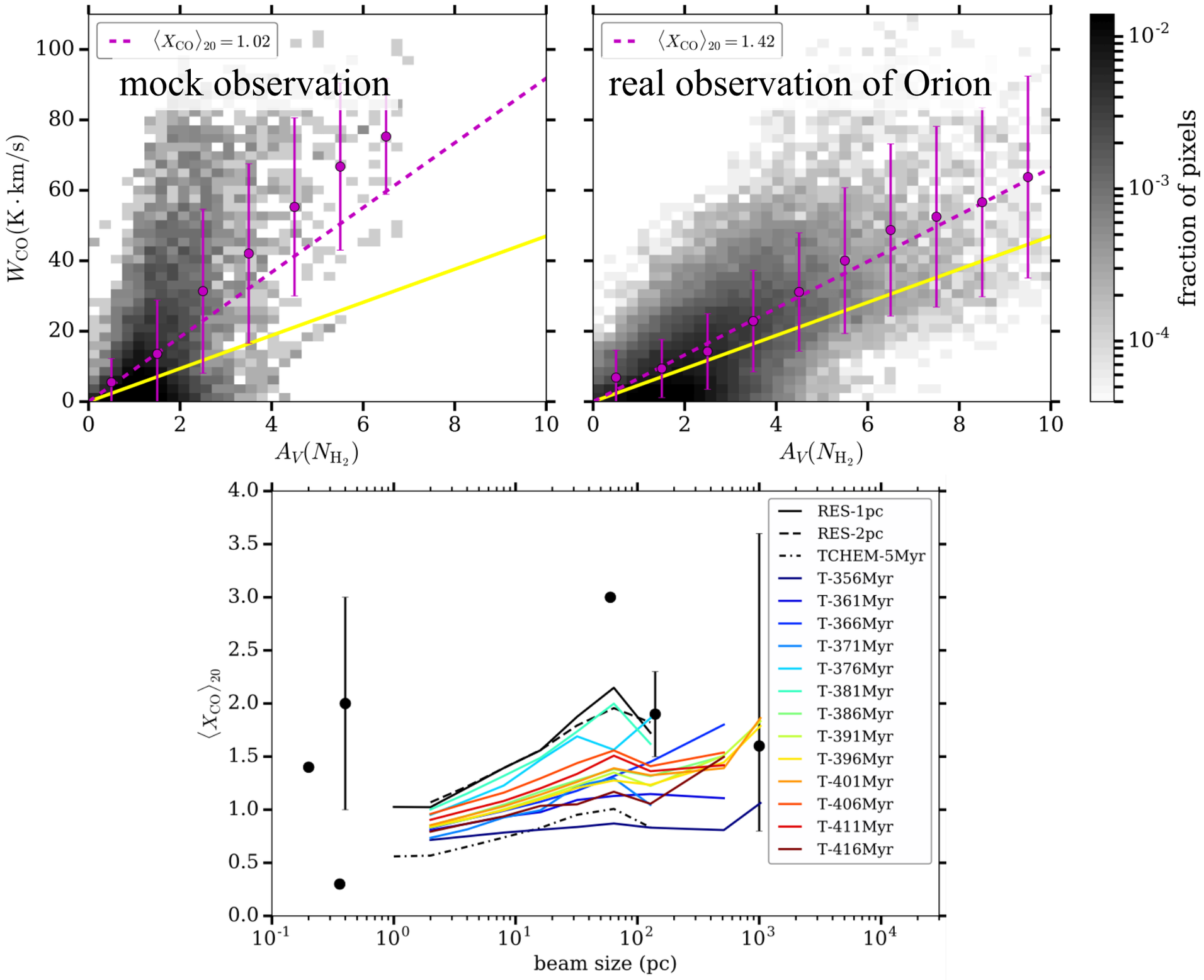


Increasing resolution

Gong, Ostriker and Kim (2018), ApJ, 858:16

The X_{CO} Conversion Factor from Galactic Multiphase ISM Simulations

The X_{CO} Conversion Factor

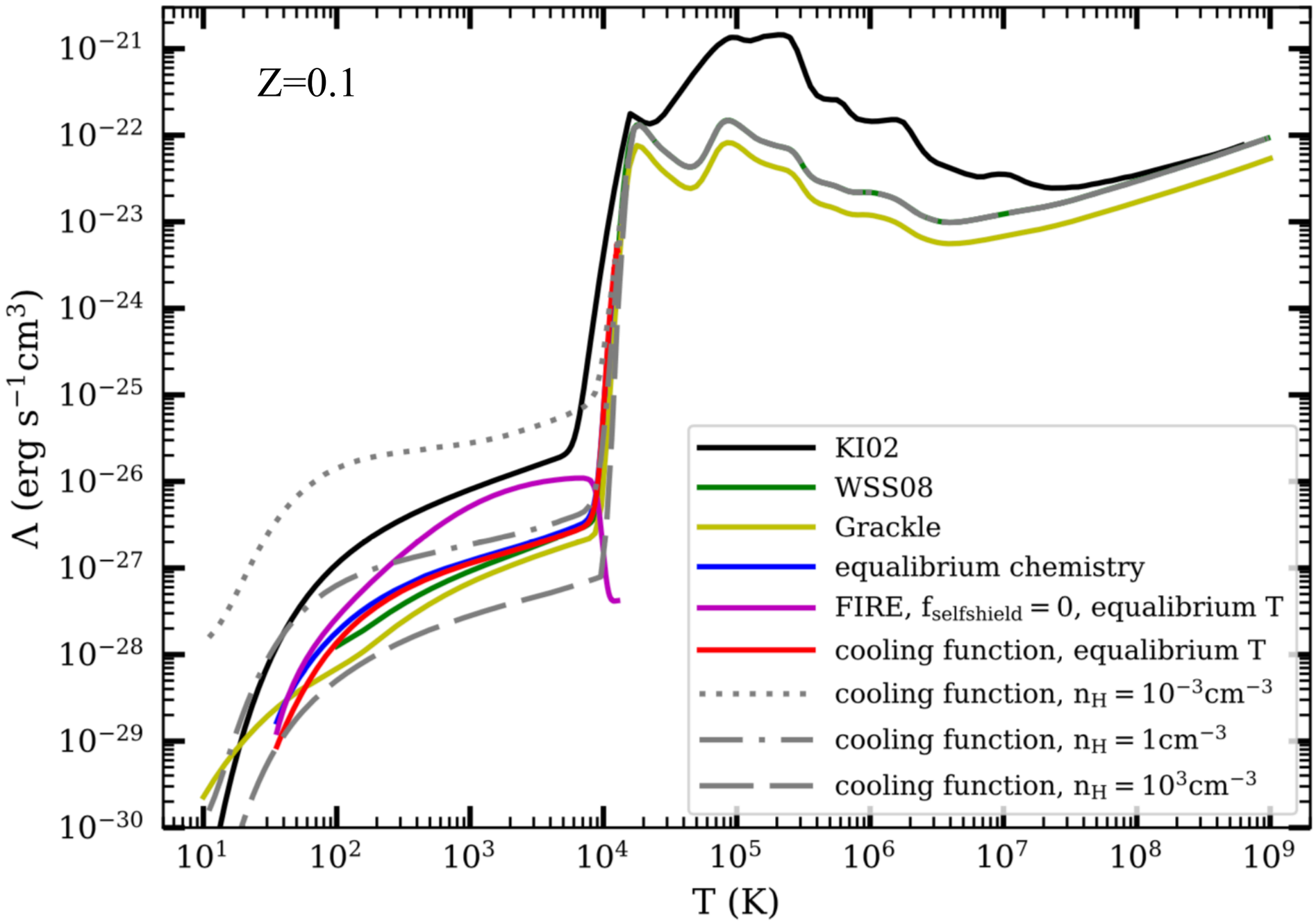


Gong, Ostriker and Kim (2018), ApJ, 858:16

The X_{CO} Conversion Factor from Galactic Multiphase ISM Simulations

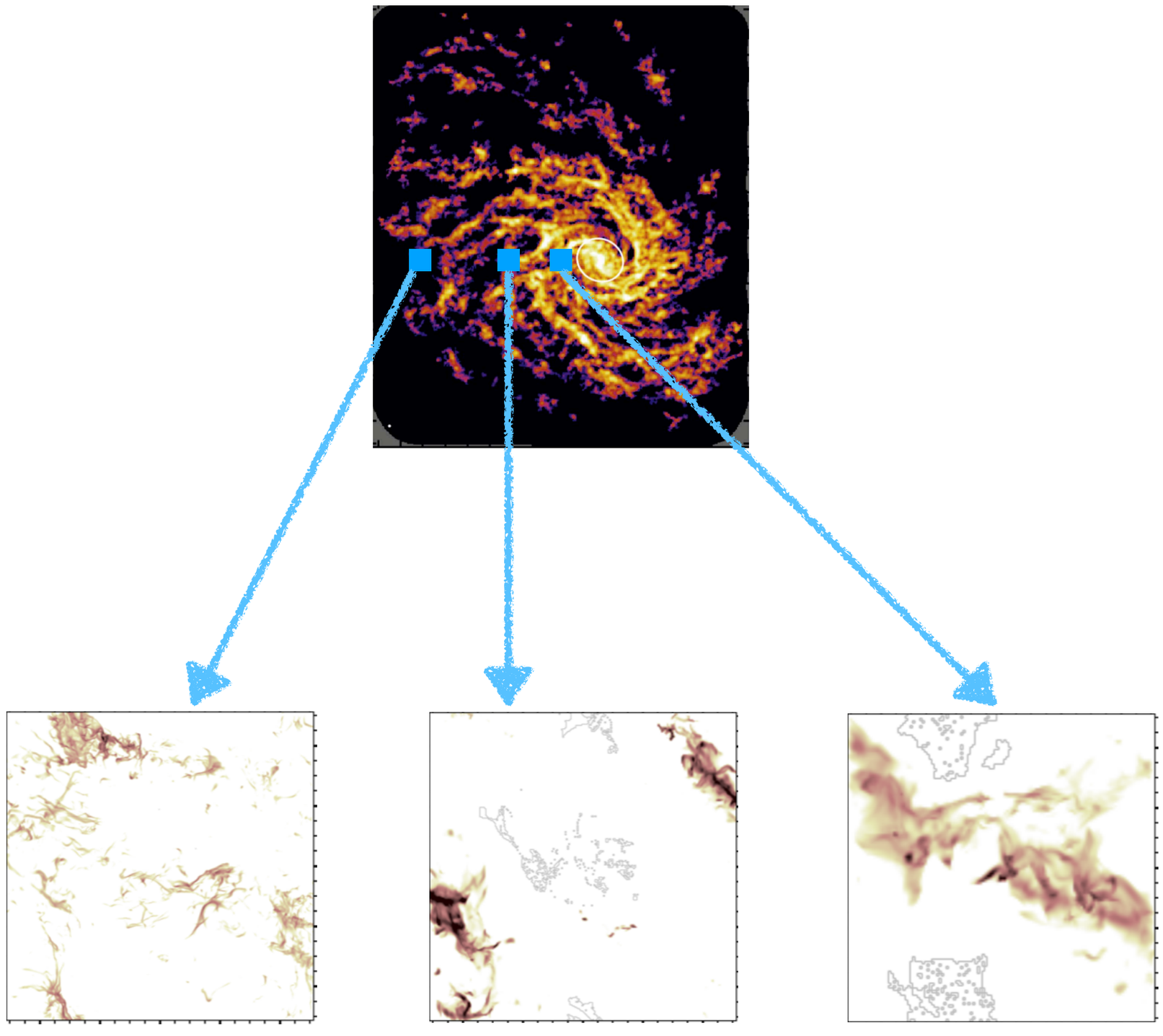
Cooling Function

- We can also do chemistry… so that we don't have to do chemistry?!



With Jeong-Gyu Kim, Eve Ostriker, Chang-Goo Kim, in prep

Beyond Our Neighbourhood

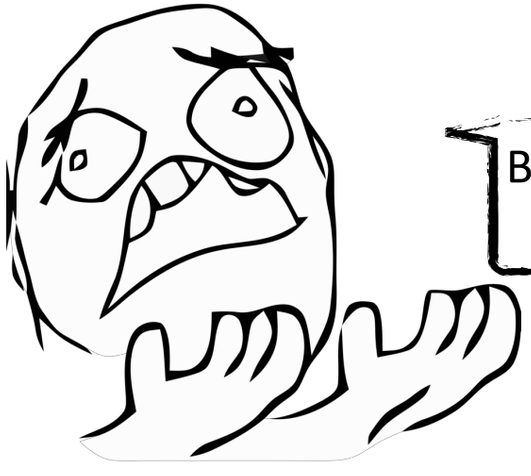


With Chang-Goo Kim, Eve Ostriker, Jeong-Gyu Kim, in prep

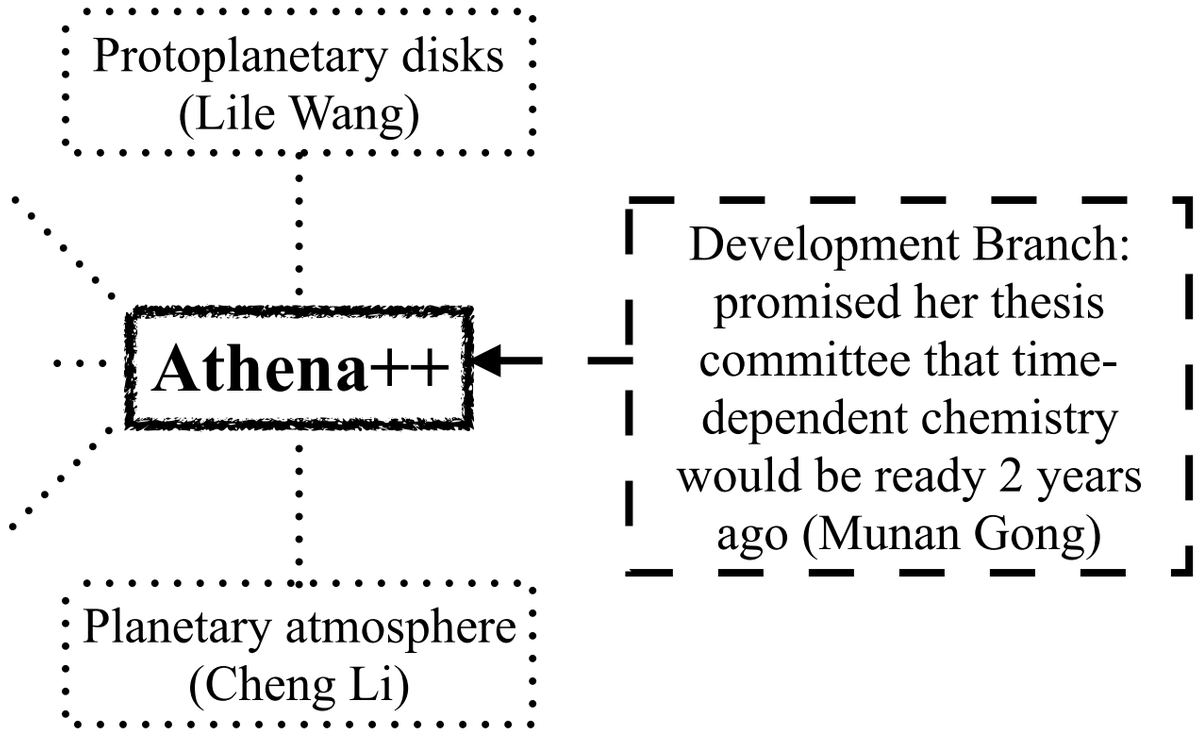
I want chemistry too!

I want chemistry too!

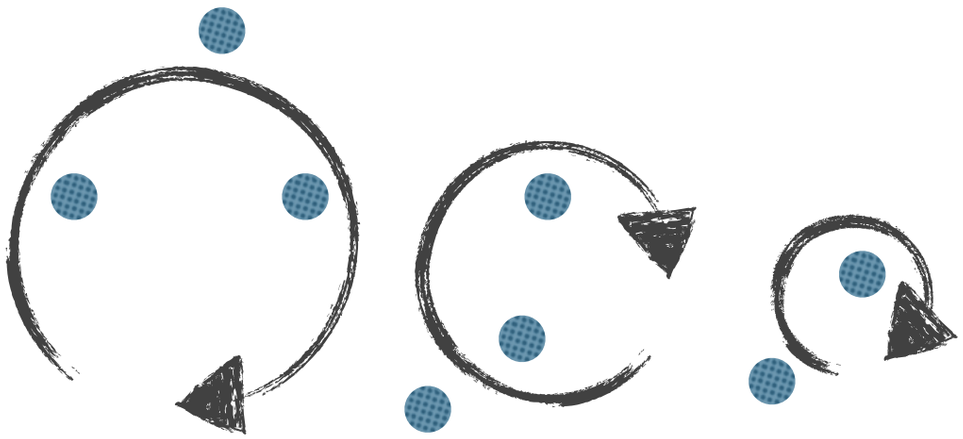
I have just heard that lots of people have done chemistry with Athena++…

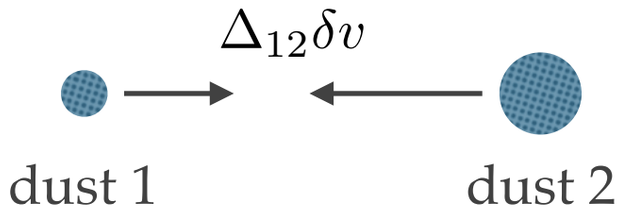


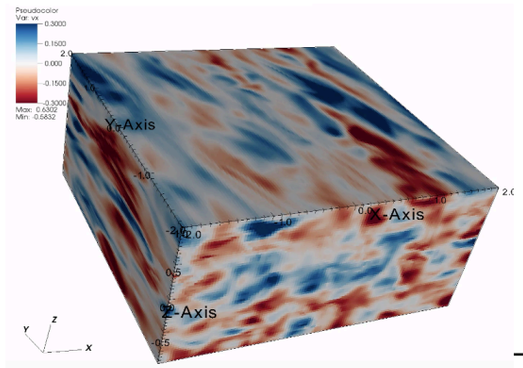
But none of them is in the public release!@#$%

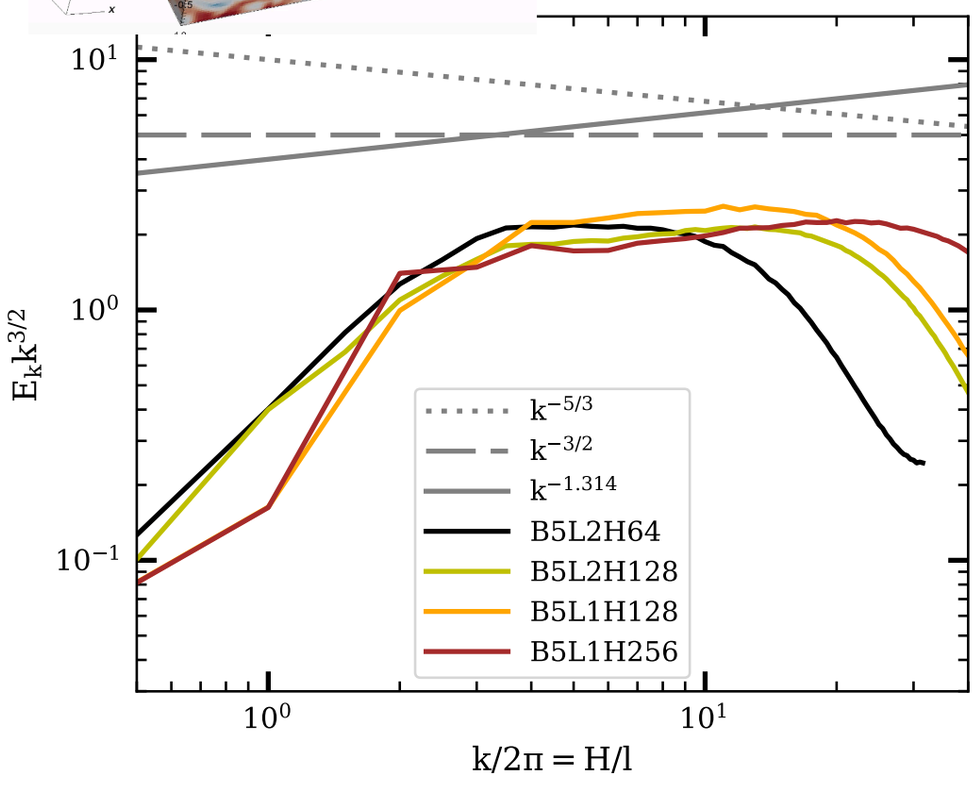


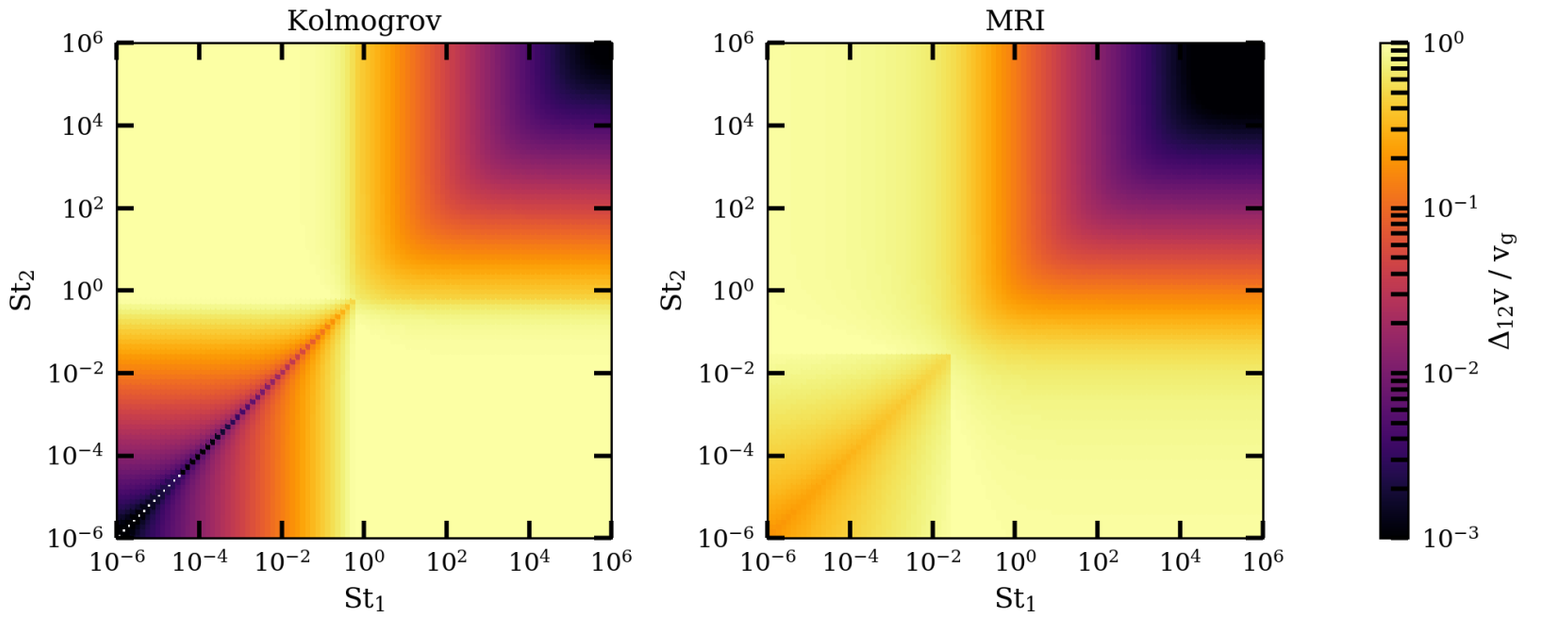
Dust Collisional Velocities in Protoplanetary Disks











With Bo Zhao, Alexei Ivlev, Paola Caselli, in prep