

Improving the estimation of Dark Matter distribution in external galaxies with deep Learning

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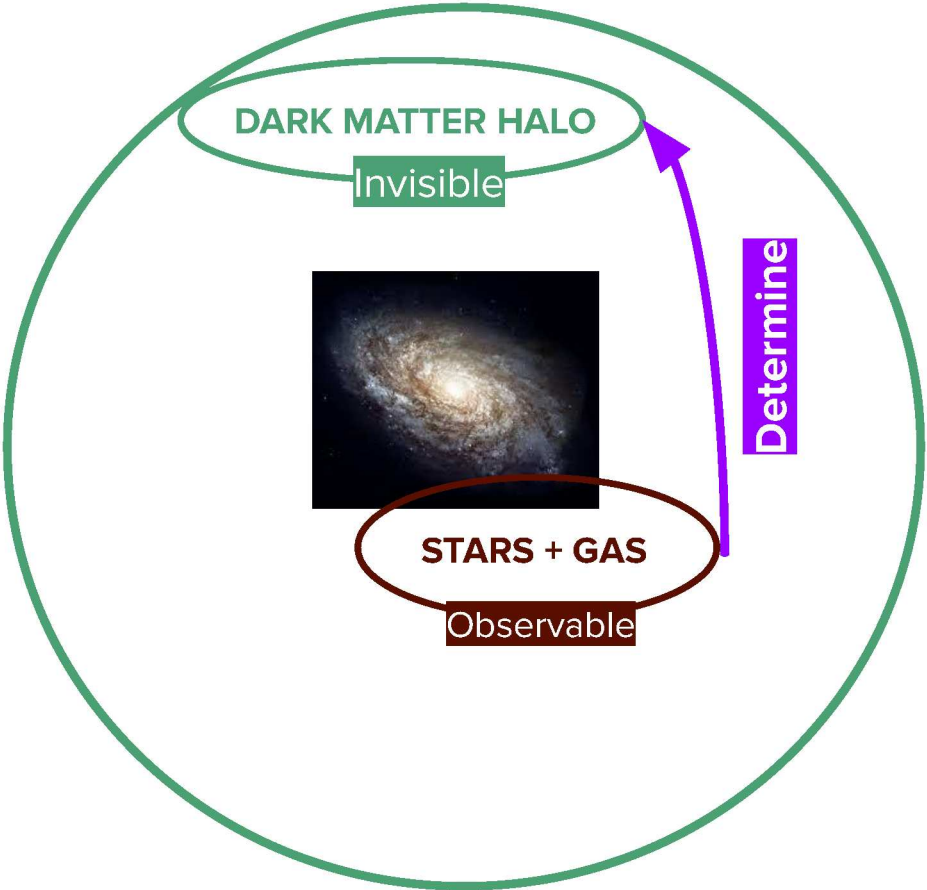
SISSA (Trieste - Italy) - INAF (Trieste - Italy) - Imperial College (London - UK)

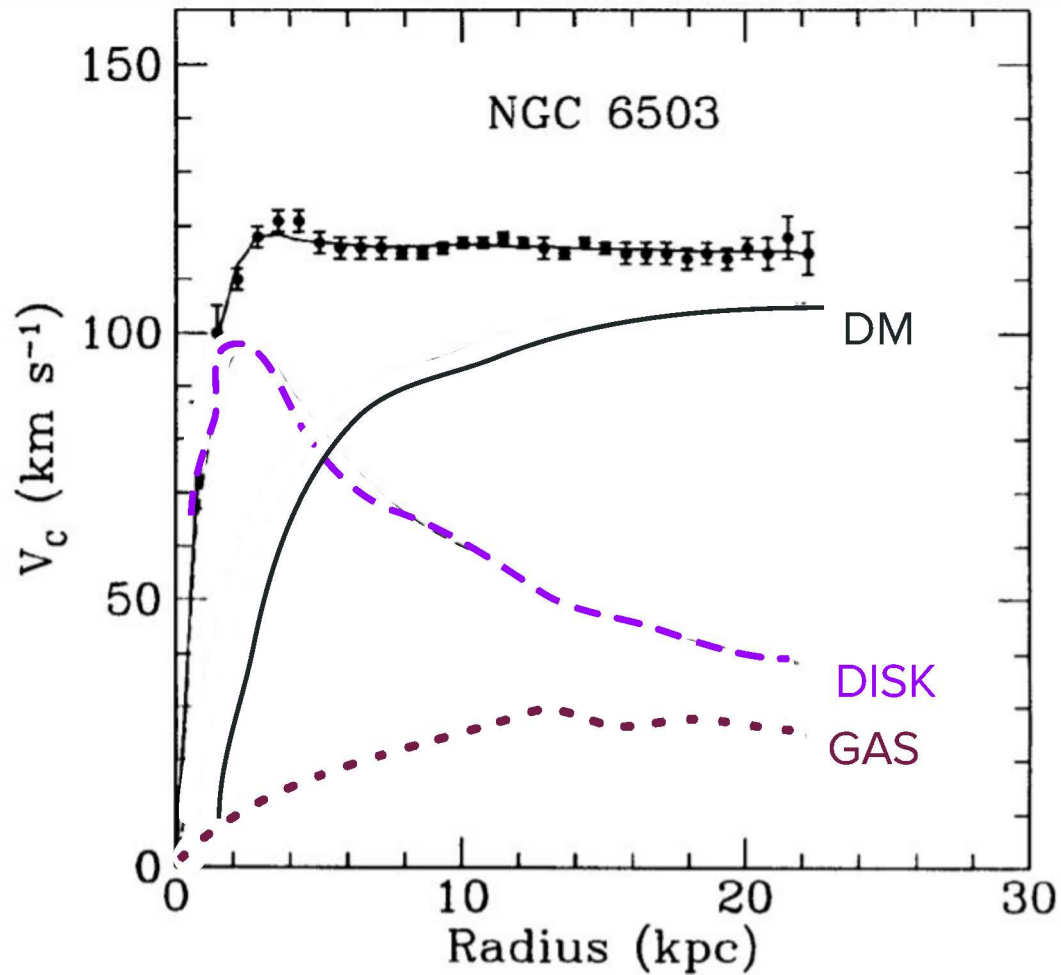
DARK MATTER HALO



STARS + GAS

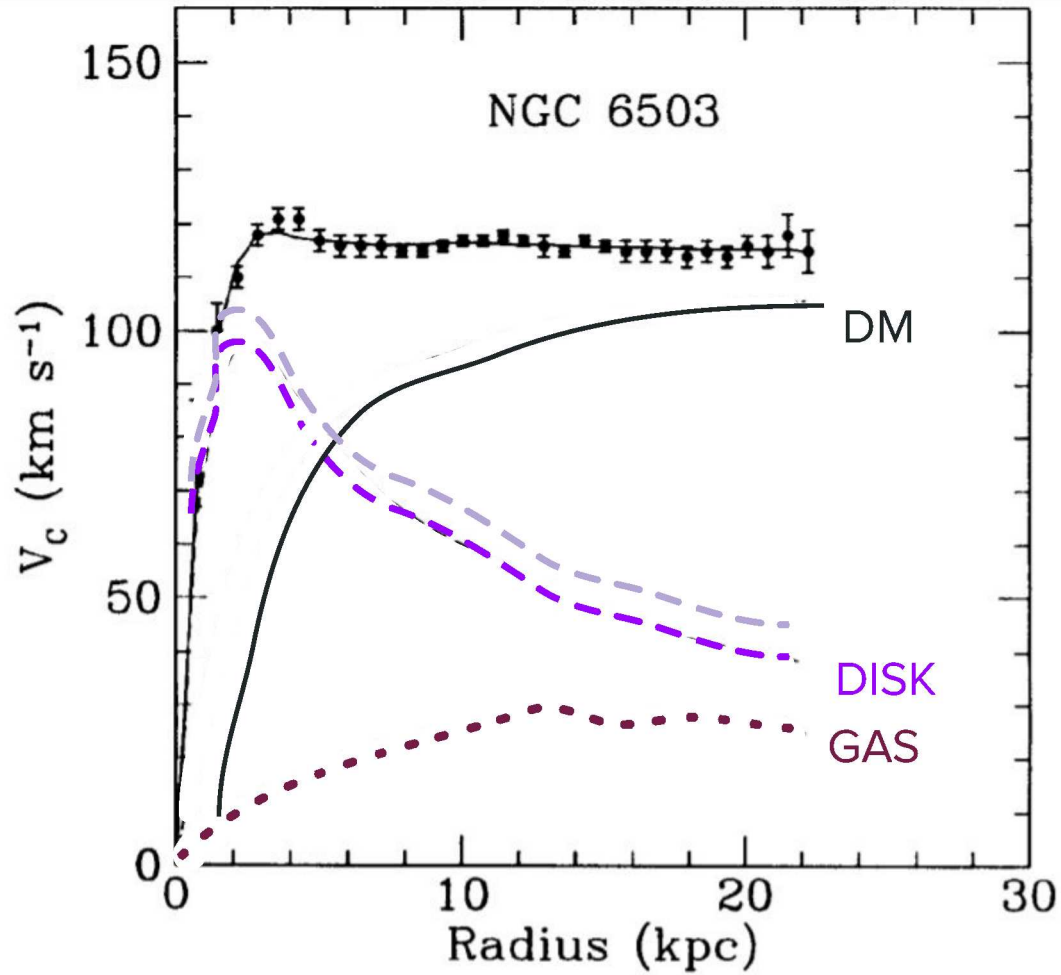






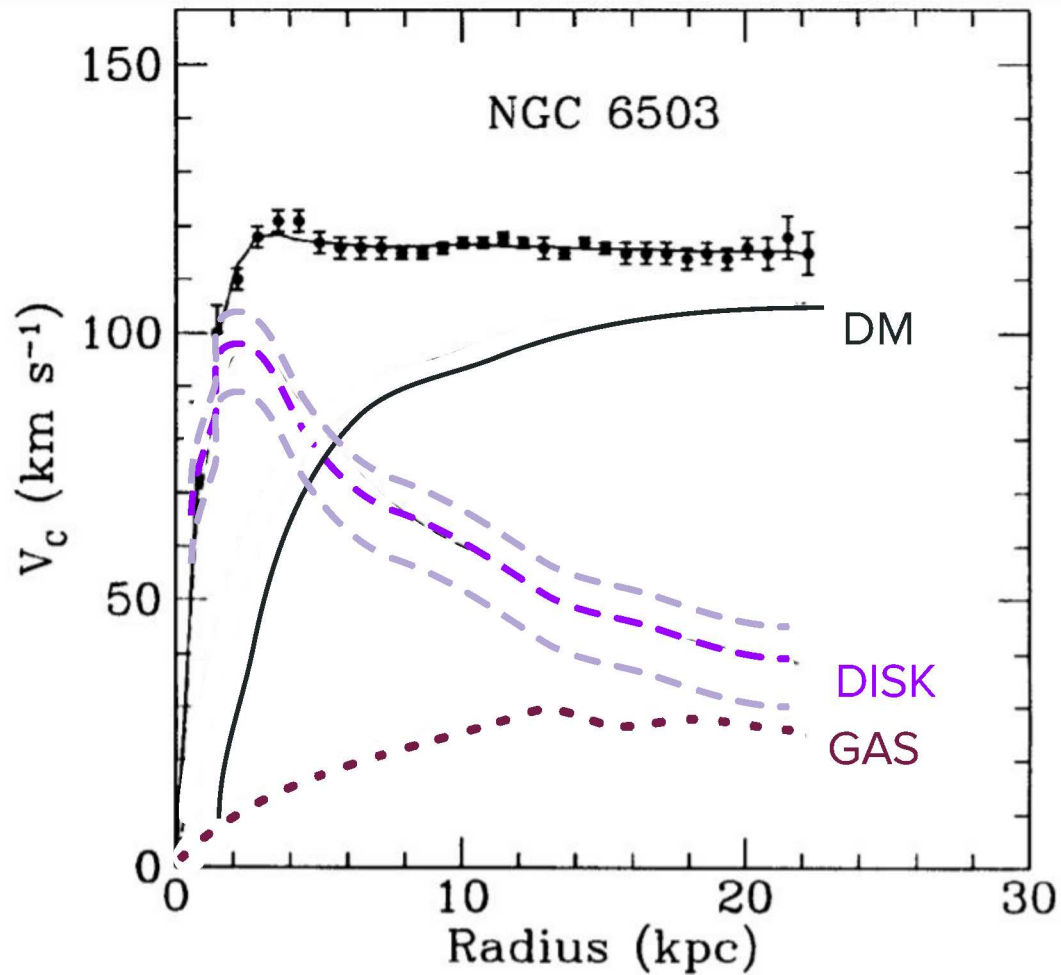
NGC 6503 Rotation Curve

[Begeman, Broeils & Sanders 1991](#)



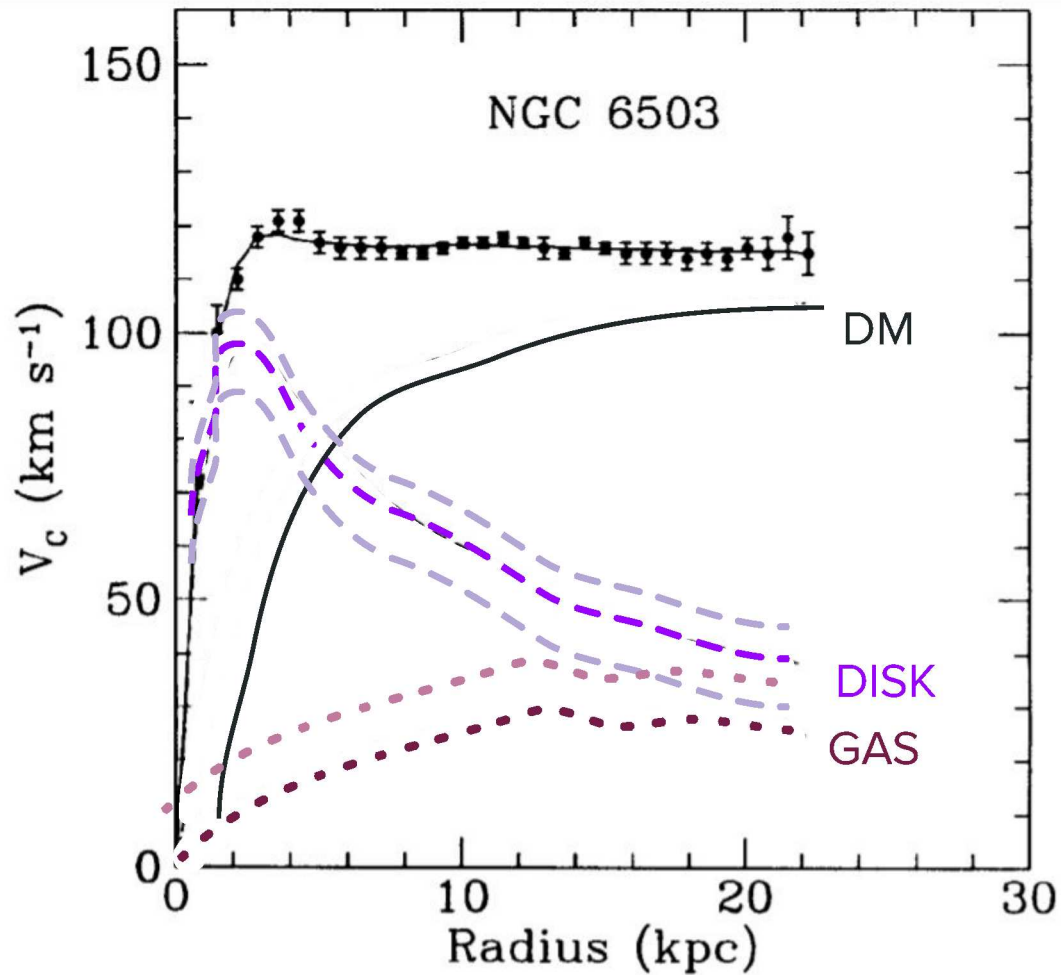
NGC 6503 Rotation Curve

[Begeman, Broeils & Sanders 1991](#)



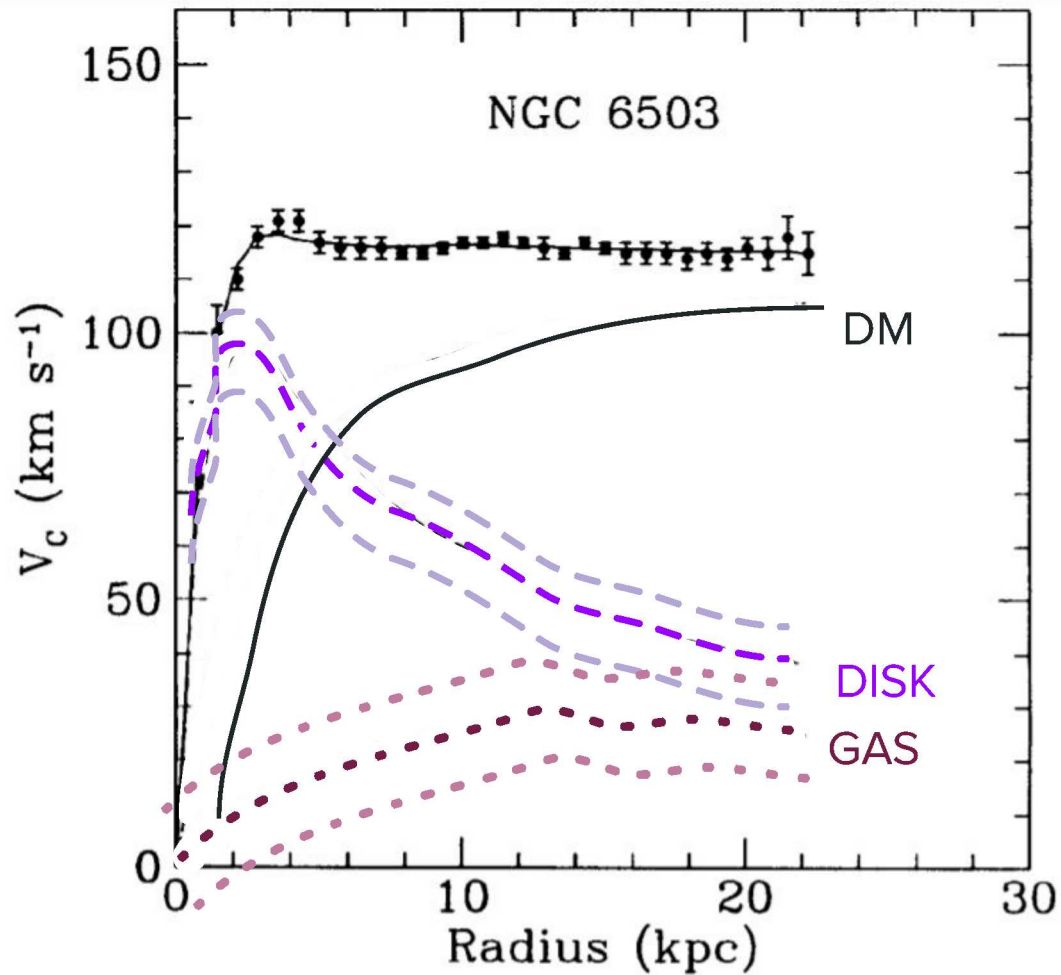
NGC 6503 Rotation Curve

[Begeman, Broeils & Sanders 1991](#)



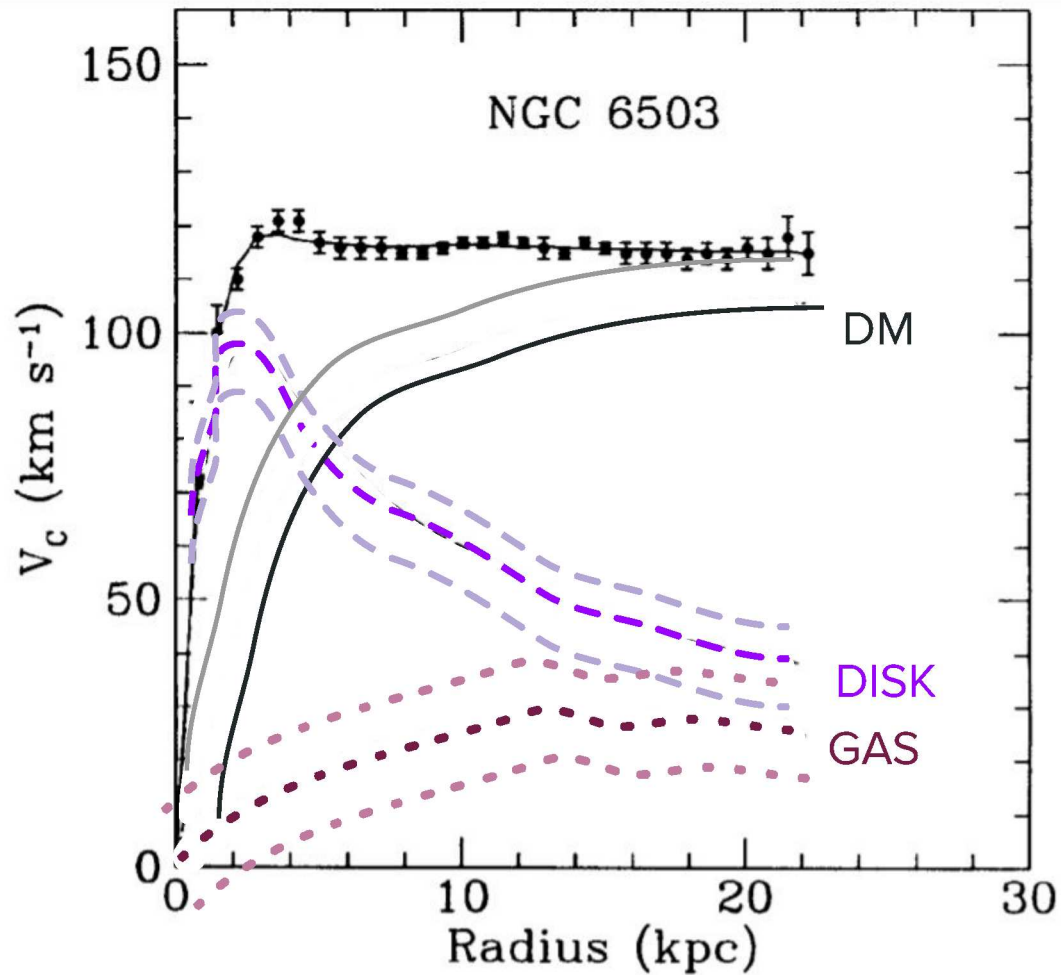
NGC 6503 Rotation Curve

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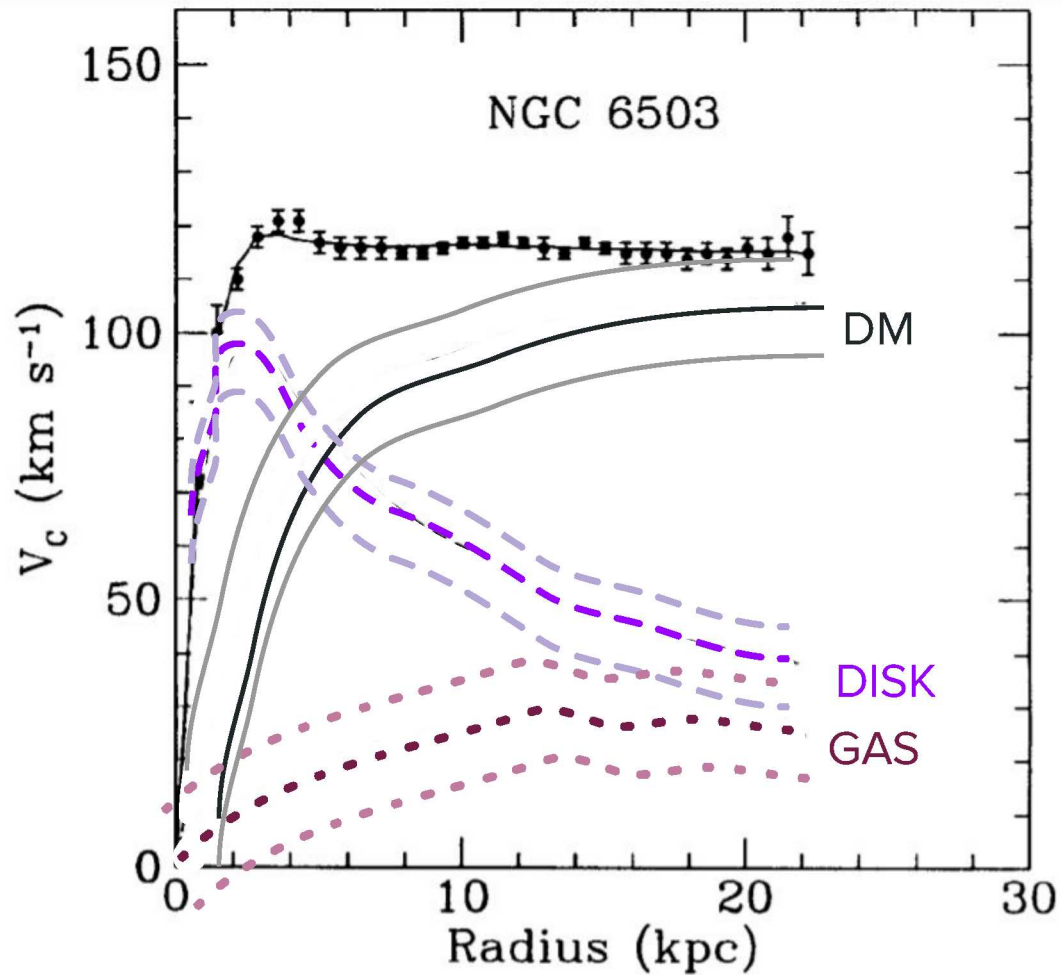
NGC 6503 Rotation Curve

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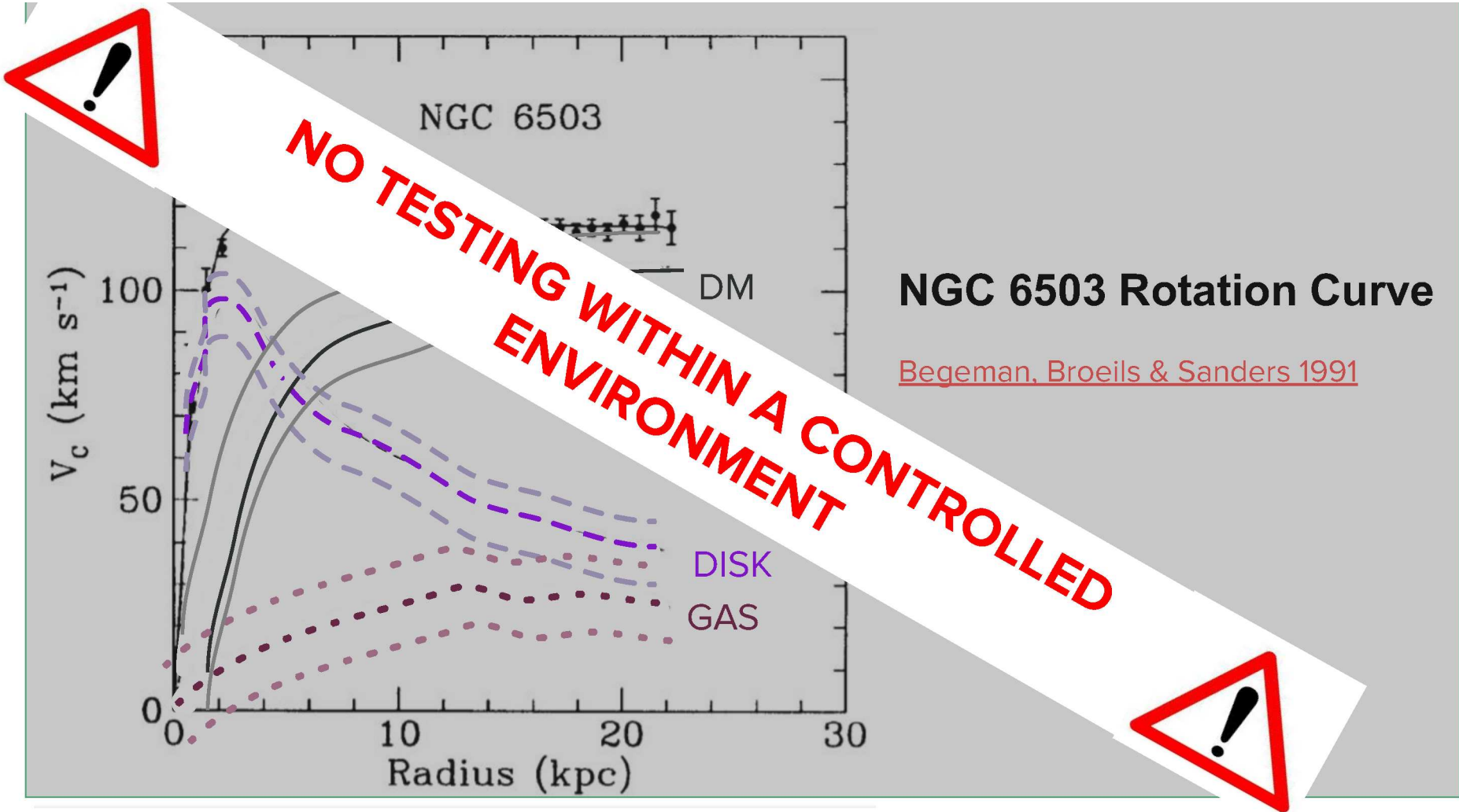
NGC 6503 Rotation Curve

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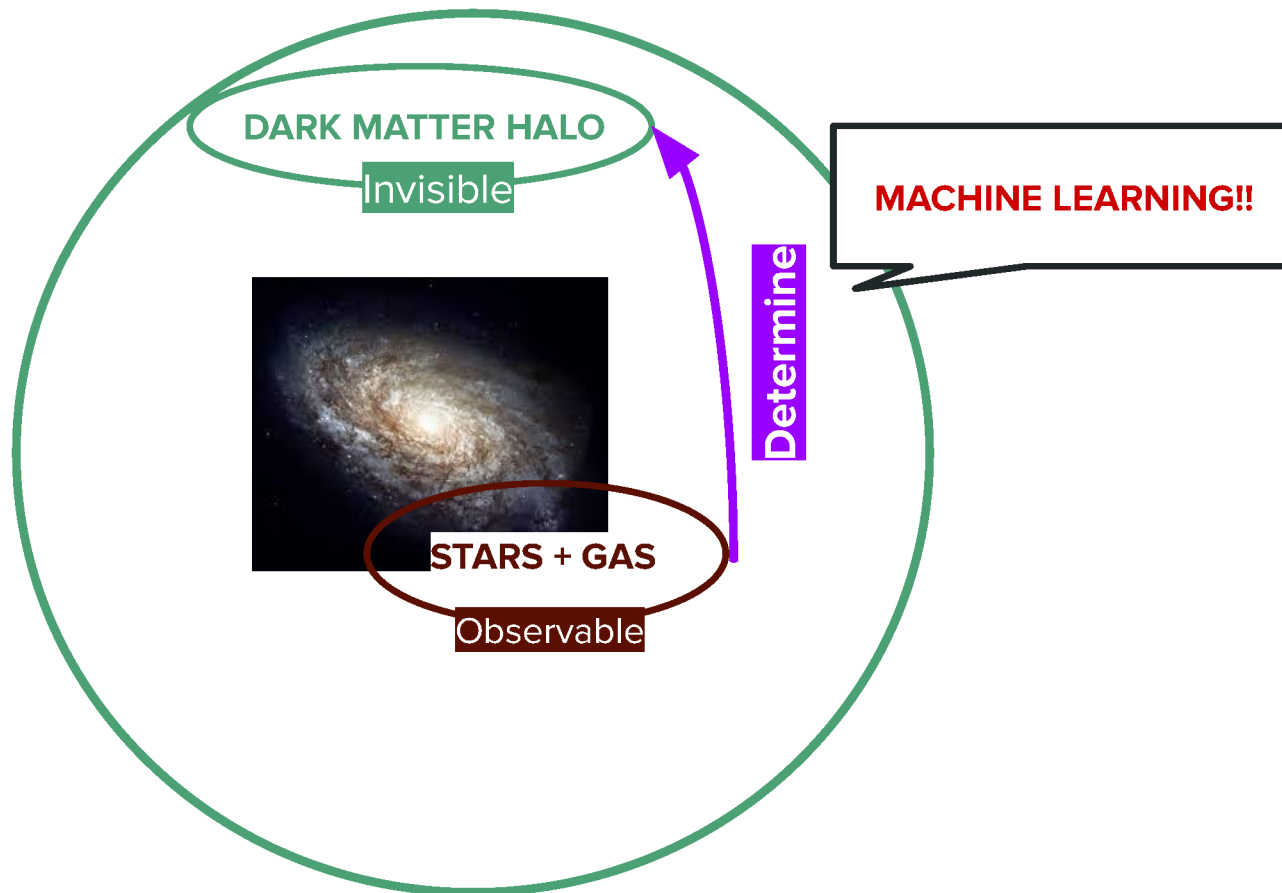
NGC 6503 Rotation Curve

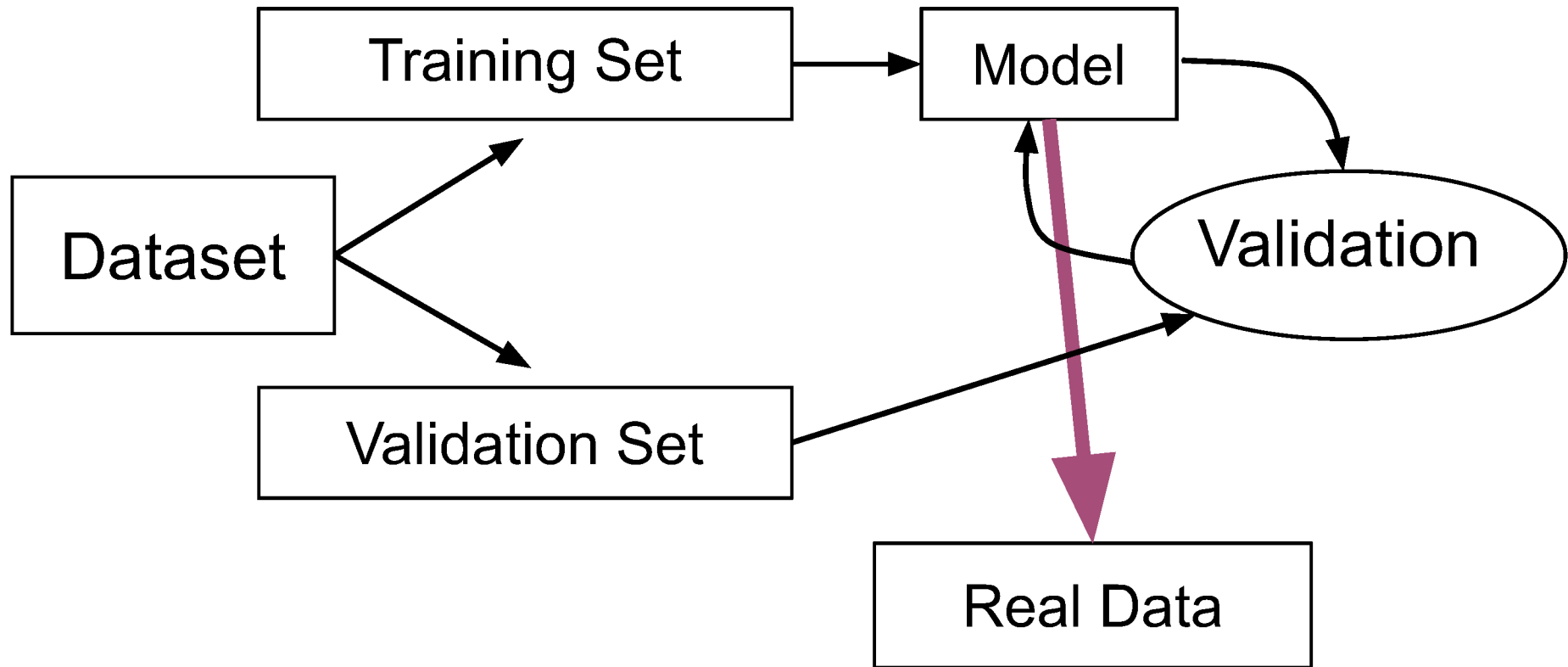
[Begeman, Broeils & Sanders 1991](#)



NGC 6503 Rotation Curve

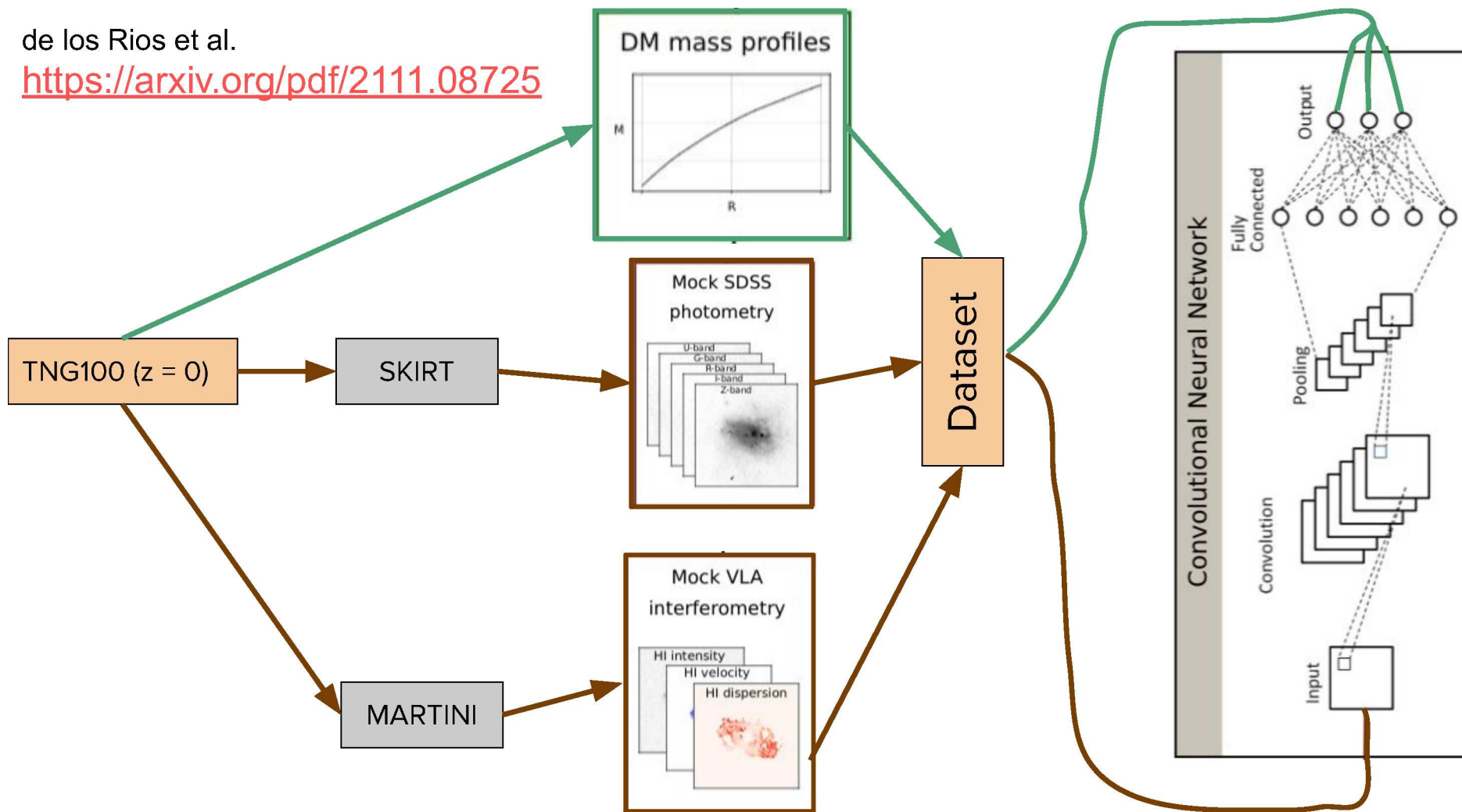
[Begeman, Broeils & Sanders 1991](#)



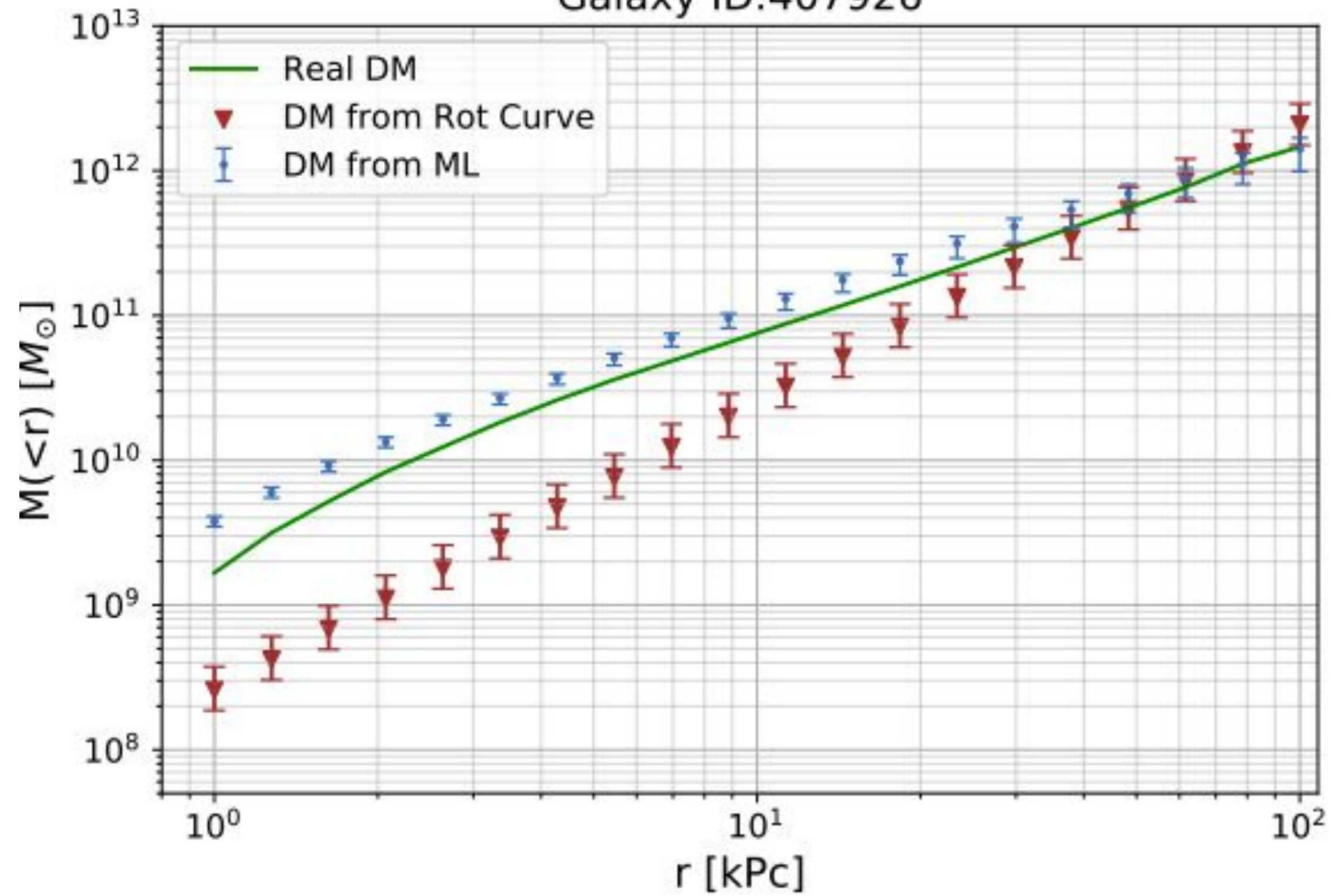


de los Rios et al.

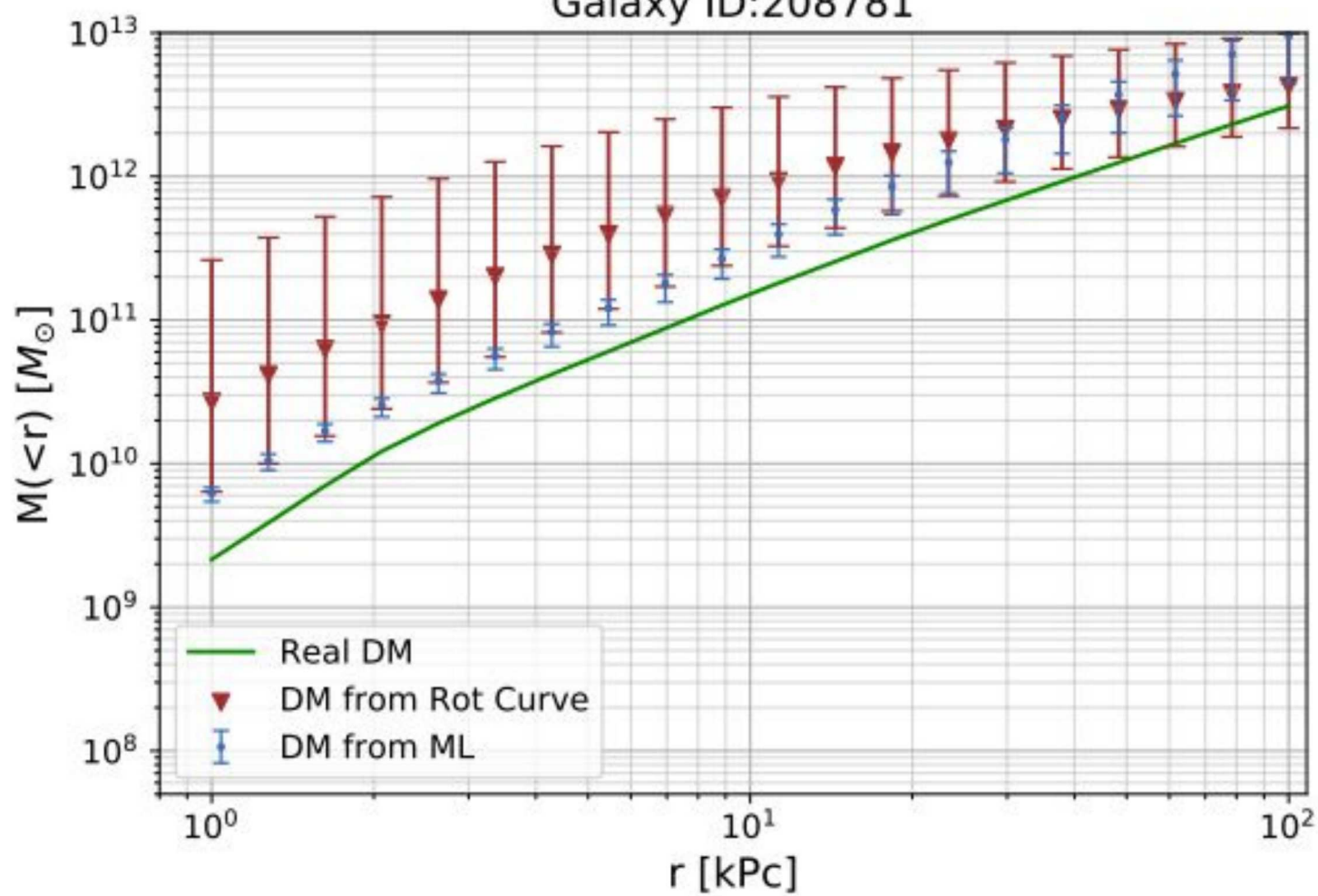
<https://arxiv.org/pdf/2111.08725>



Galaxy ID:407926



Galaxy ID:208781



Take home points....

- We present a first proof of concept demonstrating that deep learning methods can estimate the dark matter distribution around galaxies directly from the photometric images and HI datacubes.
 - Traditional rotation curves methods **ARE NOT TESTED** within a controlled environment and **WERE NOT PROBED** to recover the real dark matter distribution.
 - Traditional rotation curves methods relies on several assumptions (circular velocities, functional form of the DM profile) that may not be fulfill in real galaxies and may introduce biases on the final results.
 - Our reconstruction of the DM distribution is completely data-driven, and does not need any assumption on the shape nor the functional form of the DM profile and does not rely on any physical assumptions regarding the dynamical state of the system.
-

Nice, but....

- **Our method relies on how realistic are the synthetic images and on what the machine are learning. So....**
 - We have to trust on the cosmological hydrodynamical simulation (subgrid physics, underlying cosmology, resolution, DM model, etc...)
 - Analyse different simulations.
 - We have to trust on the codes for creating the images from the simulated galaxies (SKIRT, MARTINI).
 - Transfer learning? Domain adaptation? Adversarial networks?
 - We have to trust on what the machines are saying to us.
 - Analyse interpretability methods.
 - Check that we are not “prior” dominated.
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A grayscale photograph of a large crowd of people at what appears to be a political rally or campaign event. In the center, a man in a suit and tie is seen from the chest up, looking towards the camera with a slight smile. The background is filled with many other people, some holding up signs. The text "THANK YOU" is overlaid in the center in a large, bold, red, sans-serif font. The entire image is set against a white background with a thin green horizontal line at the bottom.

THANK YOU