

# IA générative en astrophysique

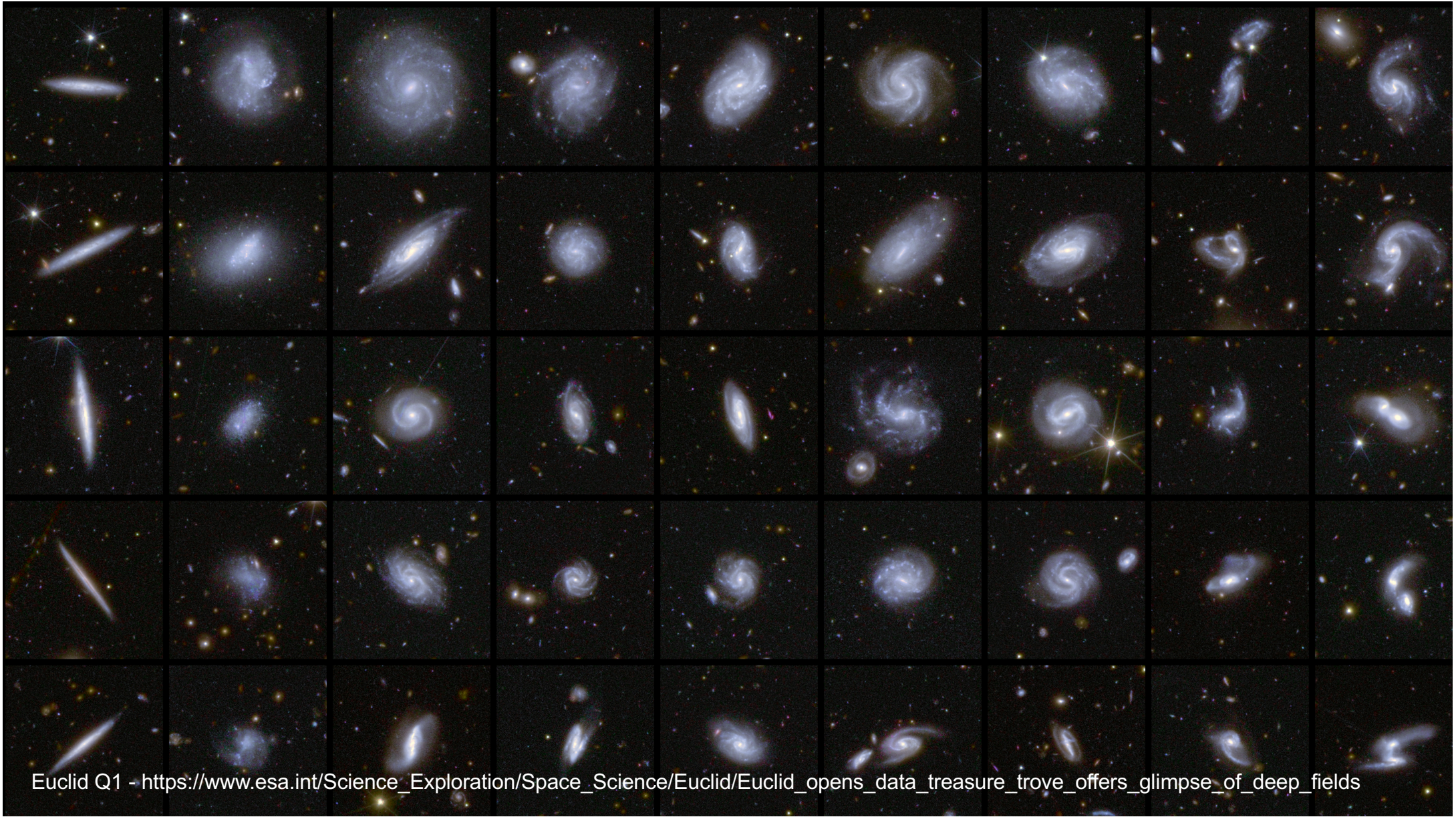
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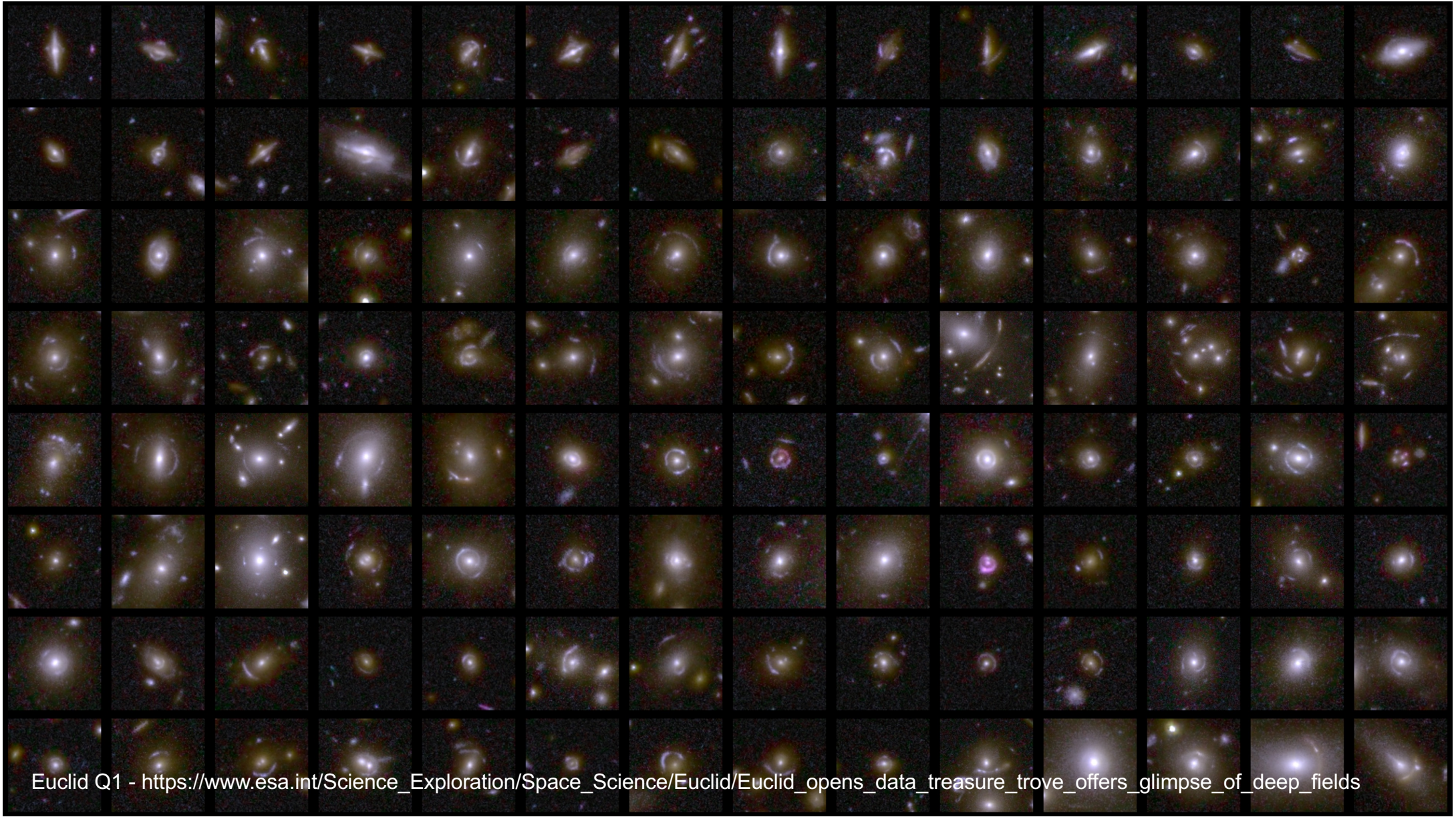
Aidé de Nabila Aghanim et Mehdi Noor





Euclid Q1 - [https://www.esa.int/Science\\_Exploration/Space\\_Science/Euclid/Euclid\\_opens\\_data\\_treasure\\_trove\\_offers\\_glimpse\\_of\\_deep\\_fields](https://www.esa.int/Science_Exploration/Space_Science/Euclid/Euclid_opens_data_treasure_trove_offers_glimpse_of_deep_fields)





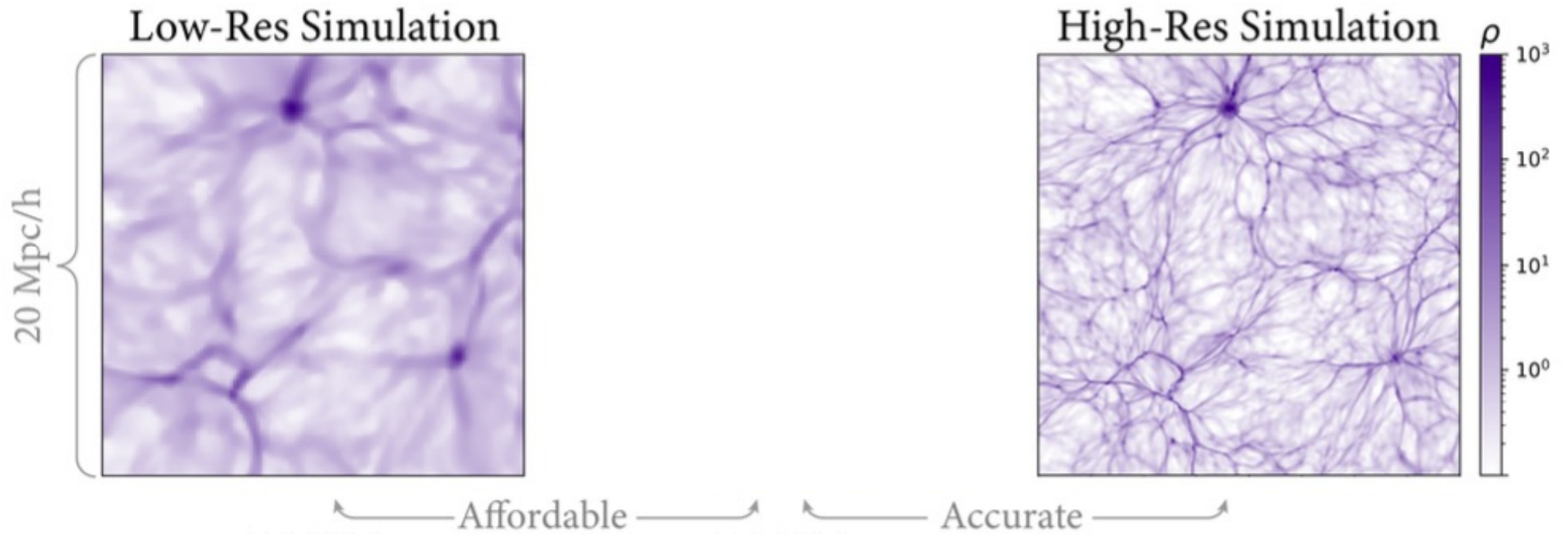
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# Enhancing cosmological simulations

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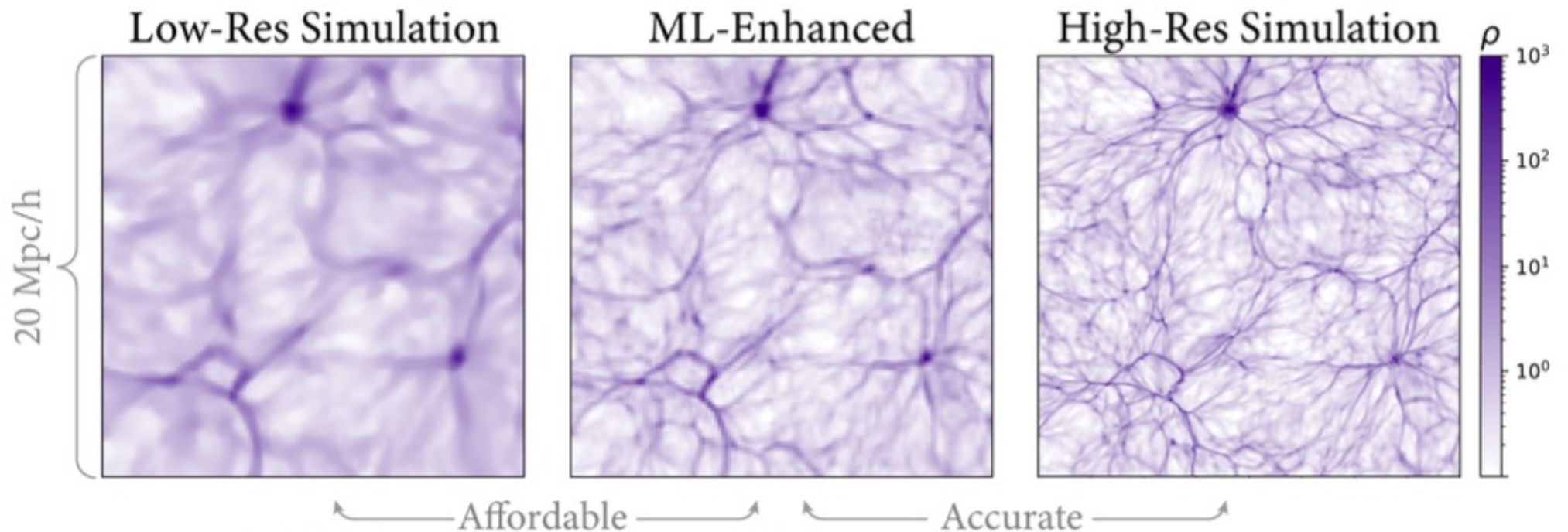




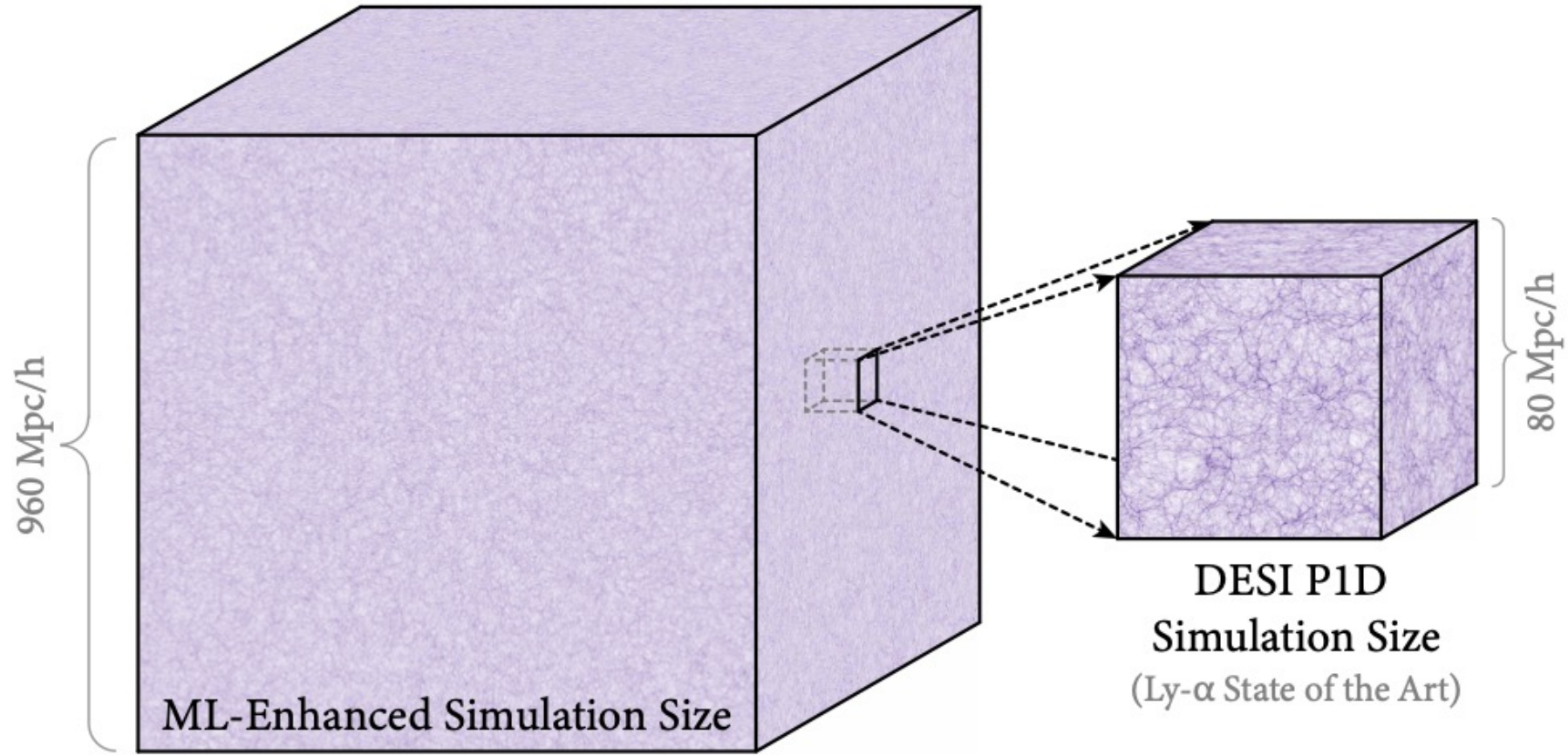
# Enhancing cosmological simulations

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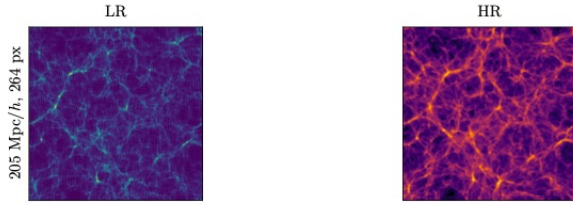




**Figure 5.** Visualization of the 960 Mpc/h wide Baryon Density volume we have reconstructed using our machine learning model. The dashed box highlights a region 80 Mpc/h wide, which is the size of our training data and comparable to existing traditional simulations used for DESI and other surveys.



### Training data



### Results

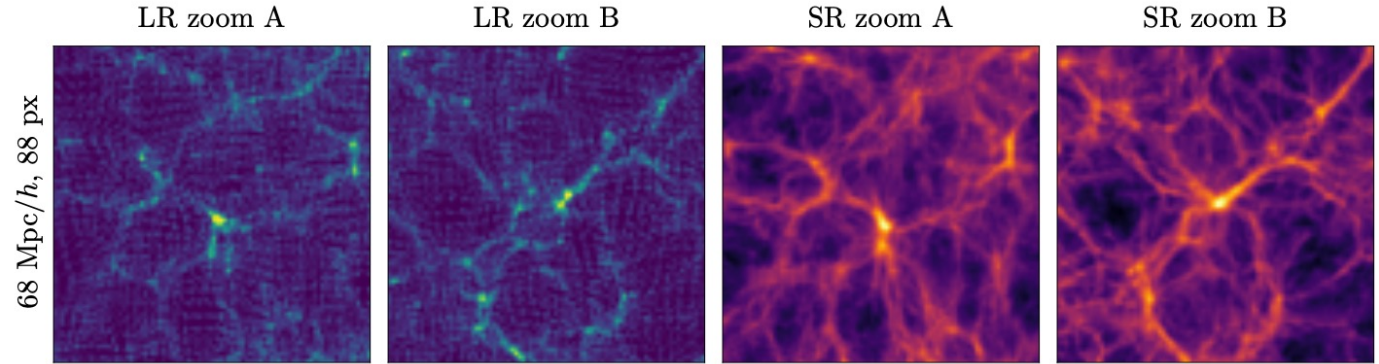
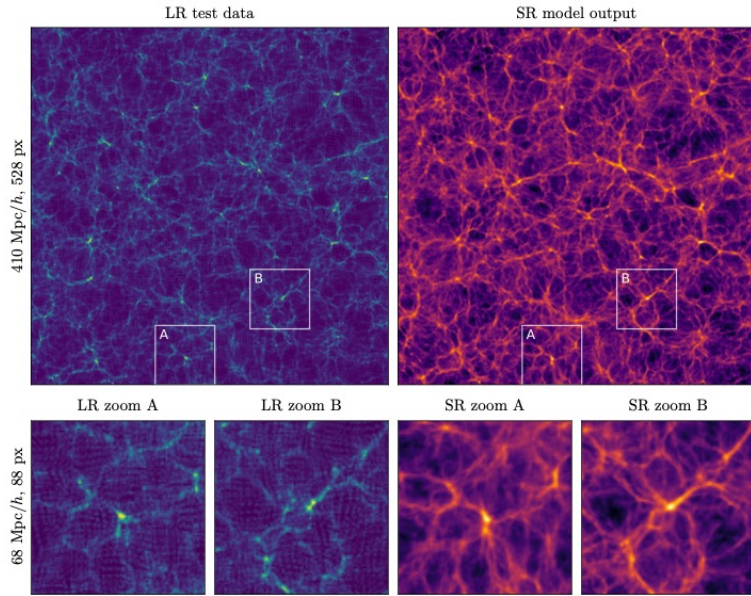


Figure 4: Matter density results for our super-resolution diffusion model in generating a volume larger than the entire training data volume. Images are 2-dimensional projections of depth 19 Mpc/h. (Top row) The training data comes from the single pair of boxes shown. The model trains on 48 px length LR-HR pairs cut out of these boxes. (Center left) LR conditional test data. (Center right) SR model output generated with  $21^3$  outpainting iterations, having 8 times the volume of the entire training data. (Bottom row) Two zoom-ins of the LR and SR fields.



### BAOs emulated from LR to SR

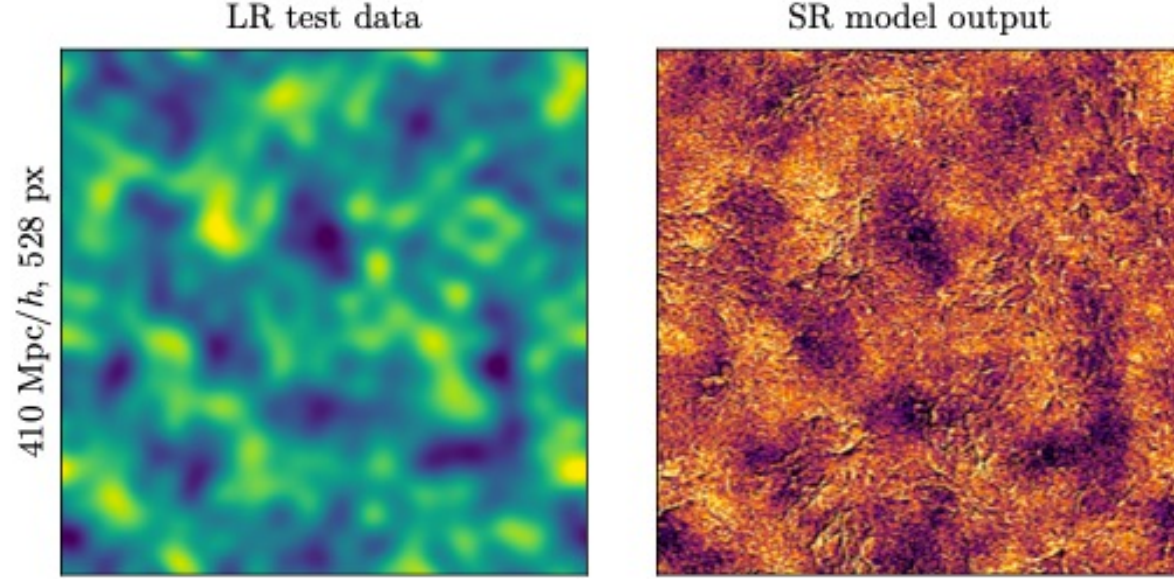
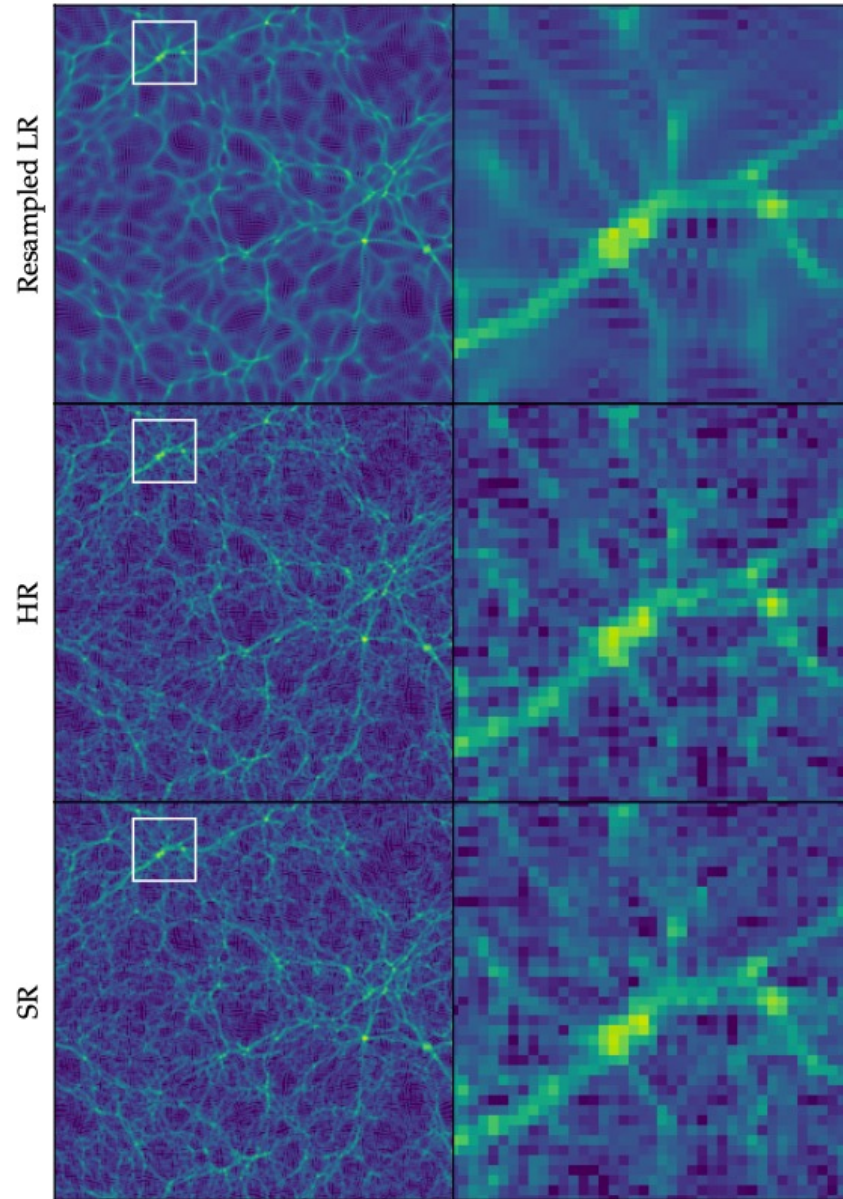


Figure 8: Field-level visualization of BAOs in the LR and SR fields,  $19 \text{ Mpc}/h$  depth 2-dimensional projections. We constructed two  $410 \text{ Mpc}/h$  length LR boxes with the same initial seed, one with BAOs and one without, and we generated their respective SR fields. Shown are the LR and SR BAOs in position space, computed as the difference between fields with and without BAOs. Large-scale fluctuations are emulated from the LR conditional to the SR model output, even though the diffusion model only trained on  $37 \text{ Mpc}/h$  length boxes.

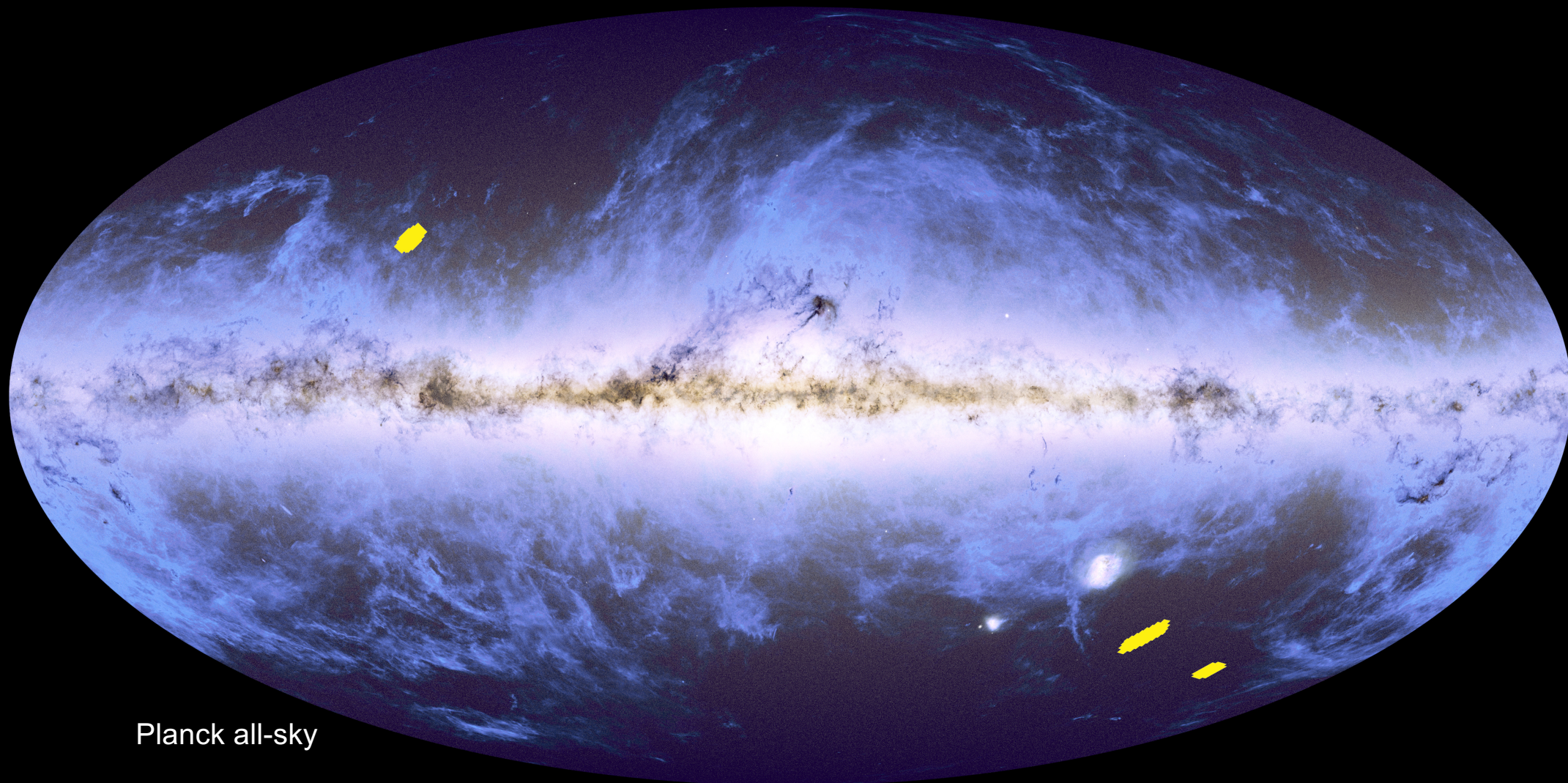


**Figure 3.** Zoom into the white box of the density fields presented in Figure 2. The top row represents the density field from the LR simulation (upsampled with Fourier interpolation to match the resolution of the HR simulation), the middle row from the HR simulation and bottom row from the SR equivalent. The inset showcases that the SR authentically reproduces the high-density nodes and even discreteness artifacts of the individual  $N$ -body particles.





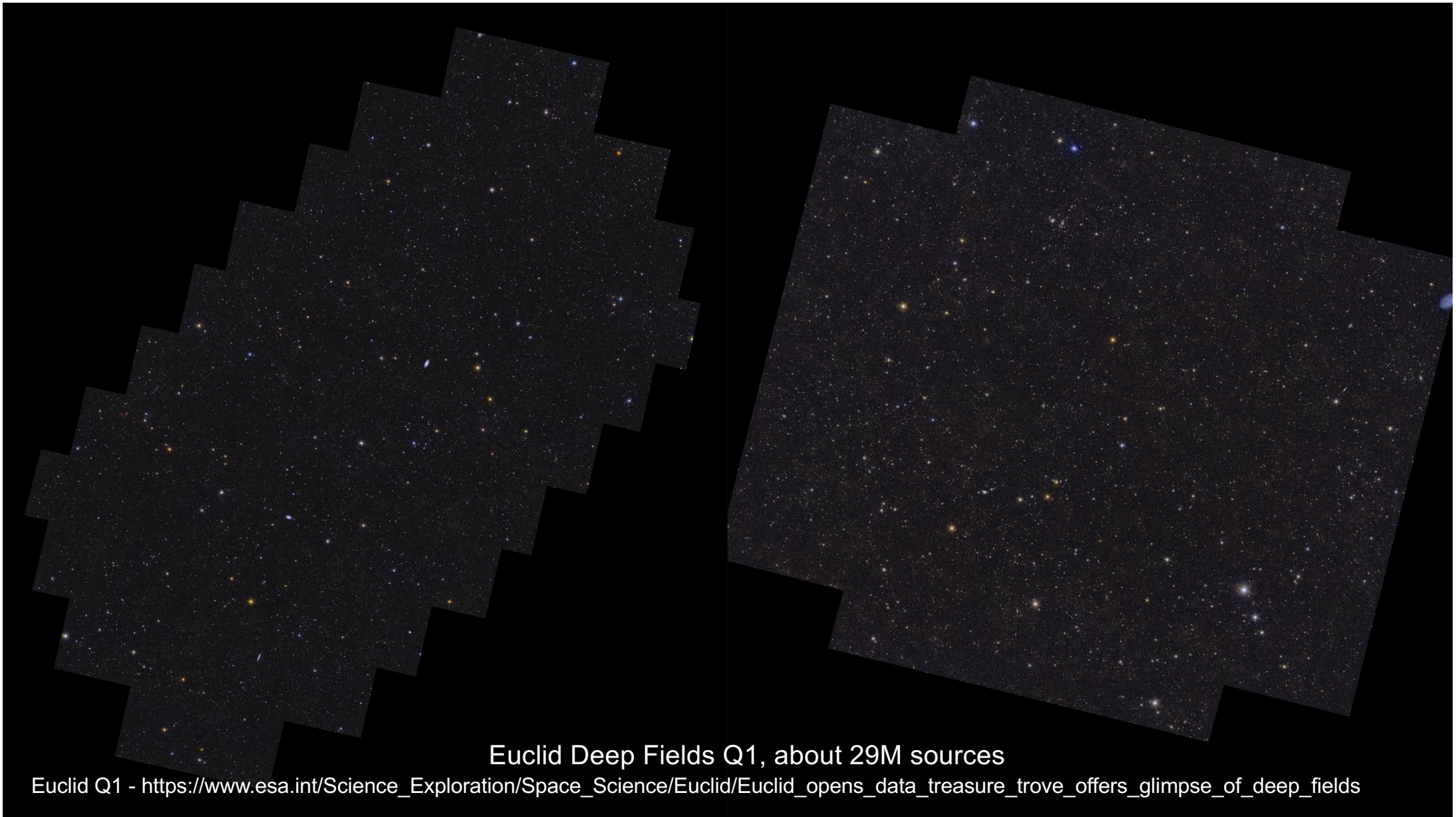
## Locations of the three Euclid Deep Fields



Planck all-sky

Euclid Q1 - [https://www.esa.int/Science\\_Exploration/Space\\_Science/Euclid/Euclid\\_opens\\_data\\_treasure\\_trove\\_offers\\_glimpse\\_of\\_deep\\_fields](https://www.esa.int/Science_Exploration/Space_Science/Euclid/Euclid_opens_data_treasure_trove_offers_glimpse_of_deep_fields)





Euclid Deep Fields Q1, about 29M sources

Euclid Q1 - [https://www.esa.int/Science\\_Exploration/Space\\_Science/Euclid/Euclid\\_opens\\_data\\_treasure\\_trove\\_offers\\_glimpse\\_of\\_deep\\_fields](https://www.esa.int/Science_Exploration/Space_Science/Euclid/Euclid_opens_data_treasure_trove_offers_glimpse_of_deep_fields)