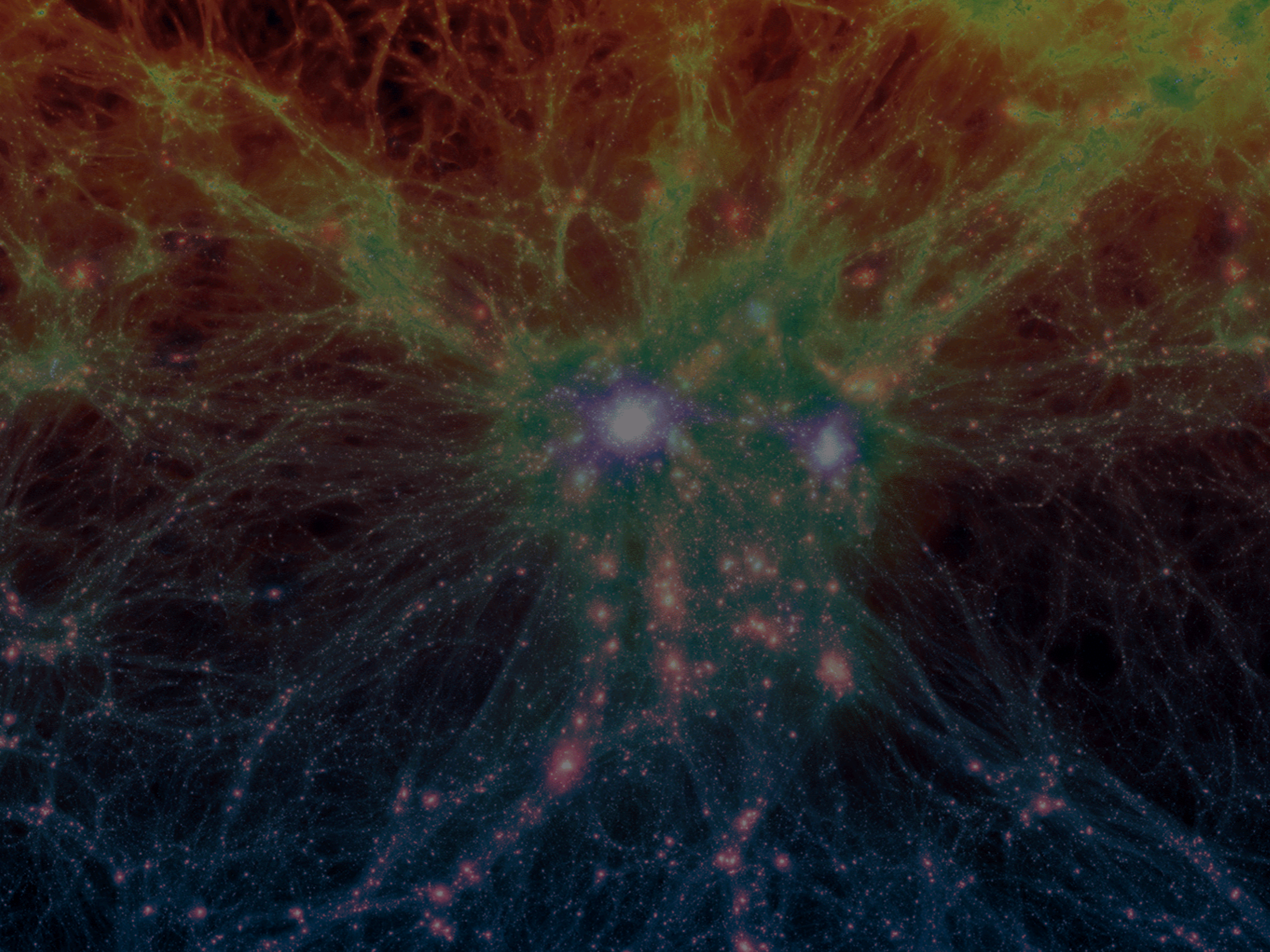


Probing dark matter with deep learning


Dr David Harvey, DARKSKIES SERI Funded ERC Starting Grant



EPFL



THE BIGGEST OBSTACLE TO
UNDERSTANDING DARK MATTER VIA
ASTRONOMICAL OBSERVATIONS IS

A visualization of the cosmic web, showing a complex network of dark matter filaments and galaxy clusters. The filaments are depicted as thin, glowing lines in shades of blue, green, and purple, connecting various galaxy clusters. The clusters themselves are represented by denser regions of red and orange points, indicating the presence of galaxies. The overall structure is a vast, interconnected web that fills the entire frame.

THE BIGGEST OBSTACLE TO
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ASTRONOMICAL OBSERVATIONS IS

*DISENTANGLING THE EFFECT OF
(PARTICLE) DARK MATTER FROM THAT OF
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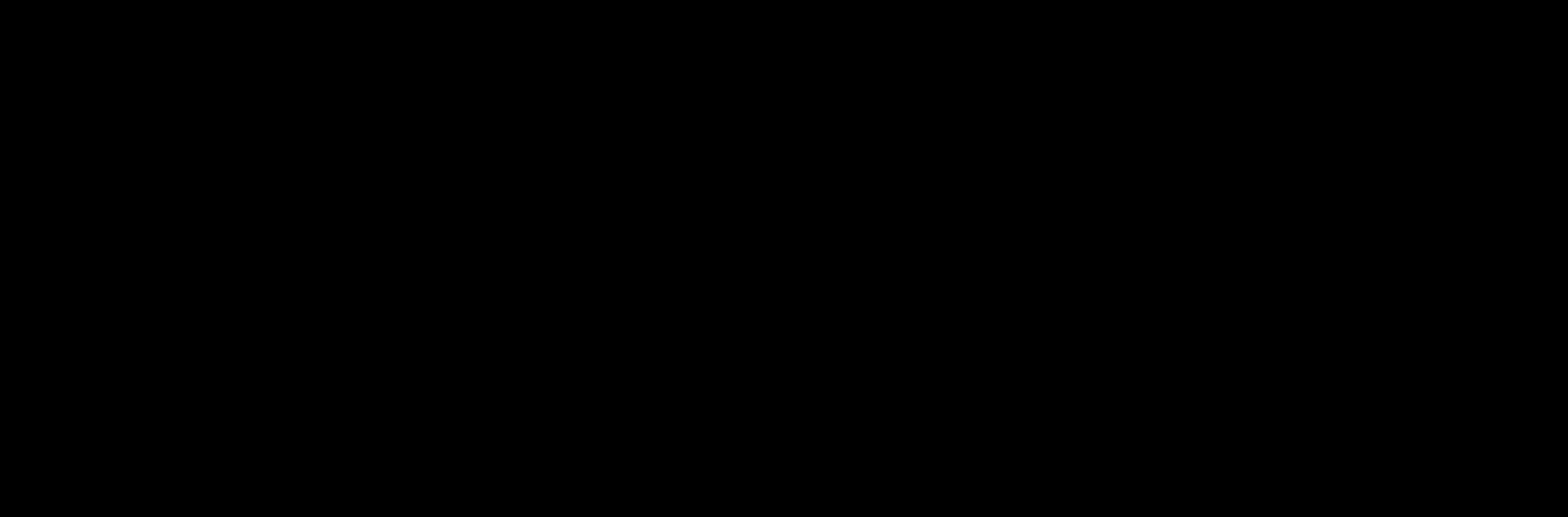
*IN ORDER TO PREDICT A CLEAR
DEVIATION FROM LCDM*

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*THAT WITH SUFFICIENT DATA CAN BE
ROBUSTLY MEASURED*

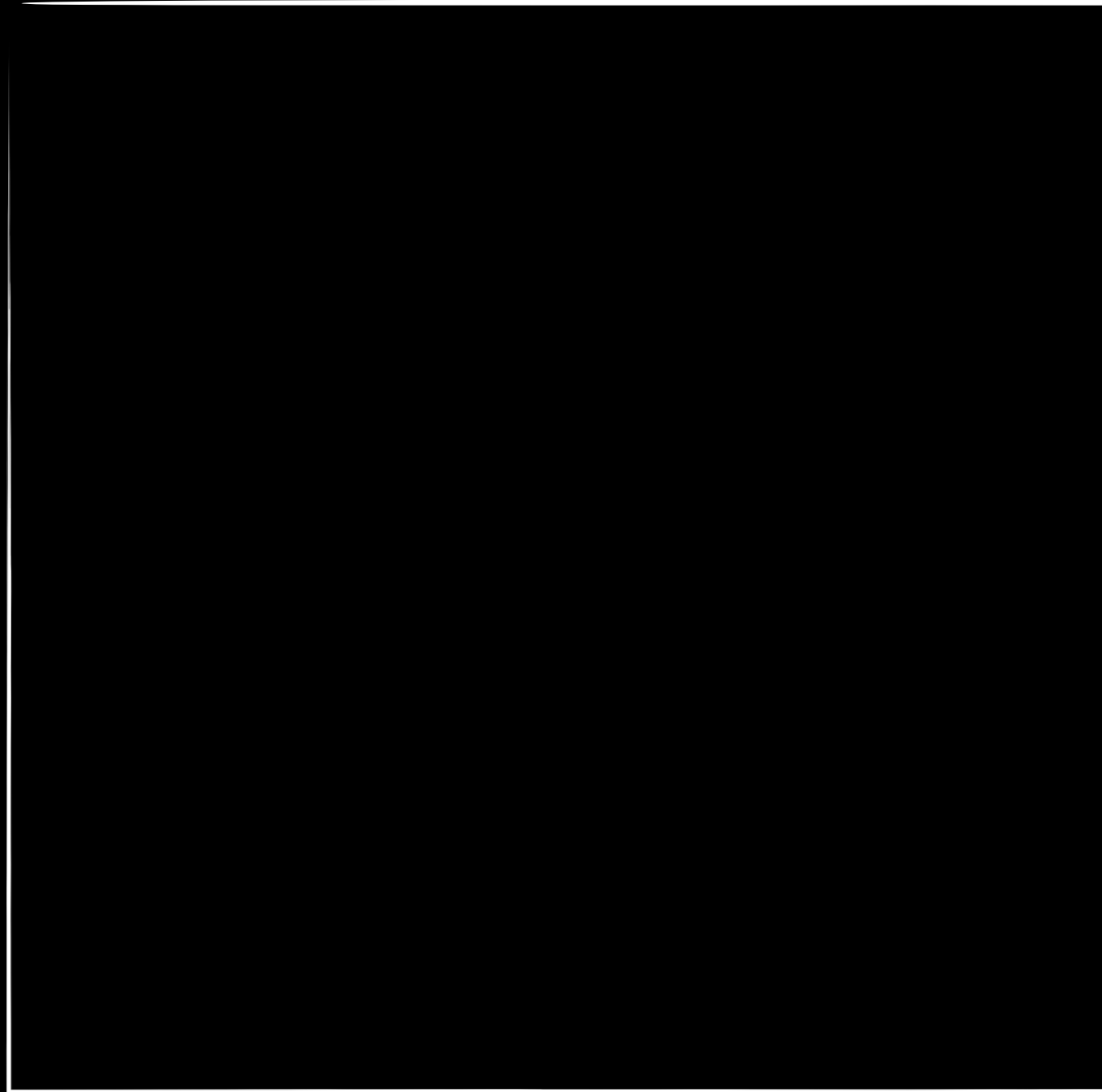




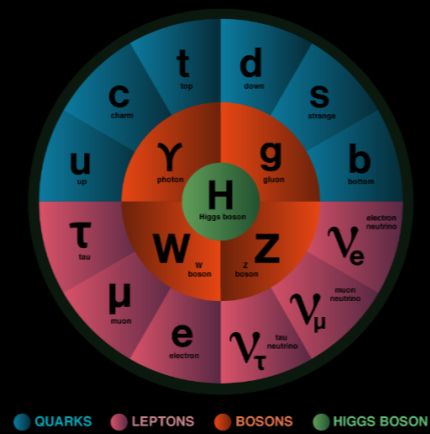
Statistics are fundamentally limited



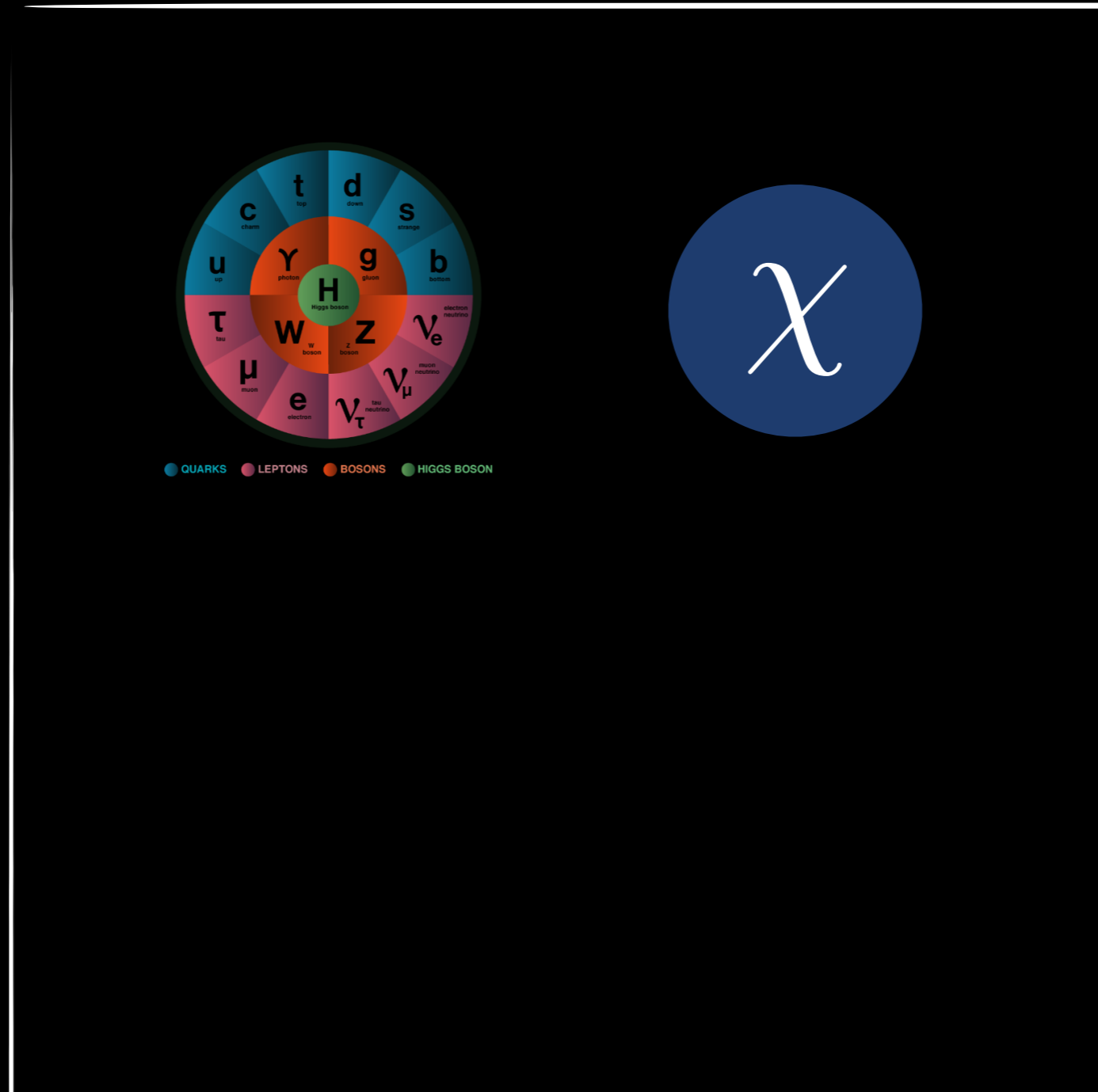
WE START BY BUILDING A MODEL OF
DARK MATTER



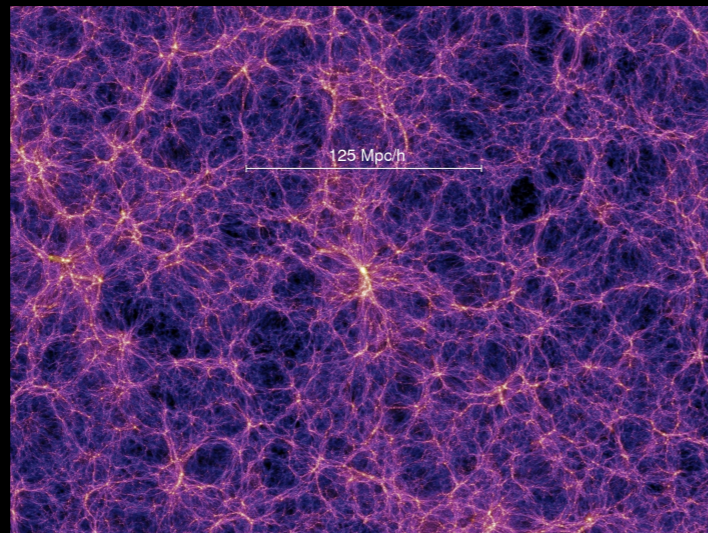
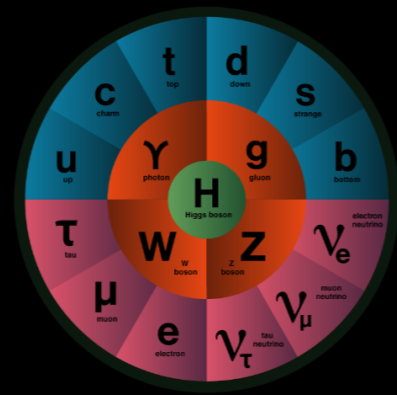
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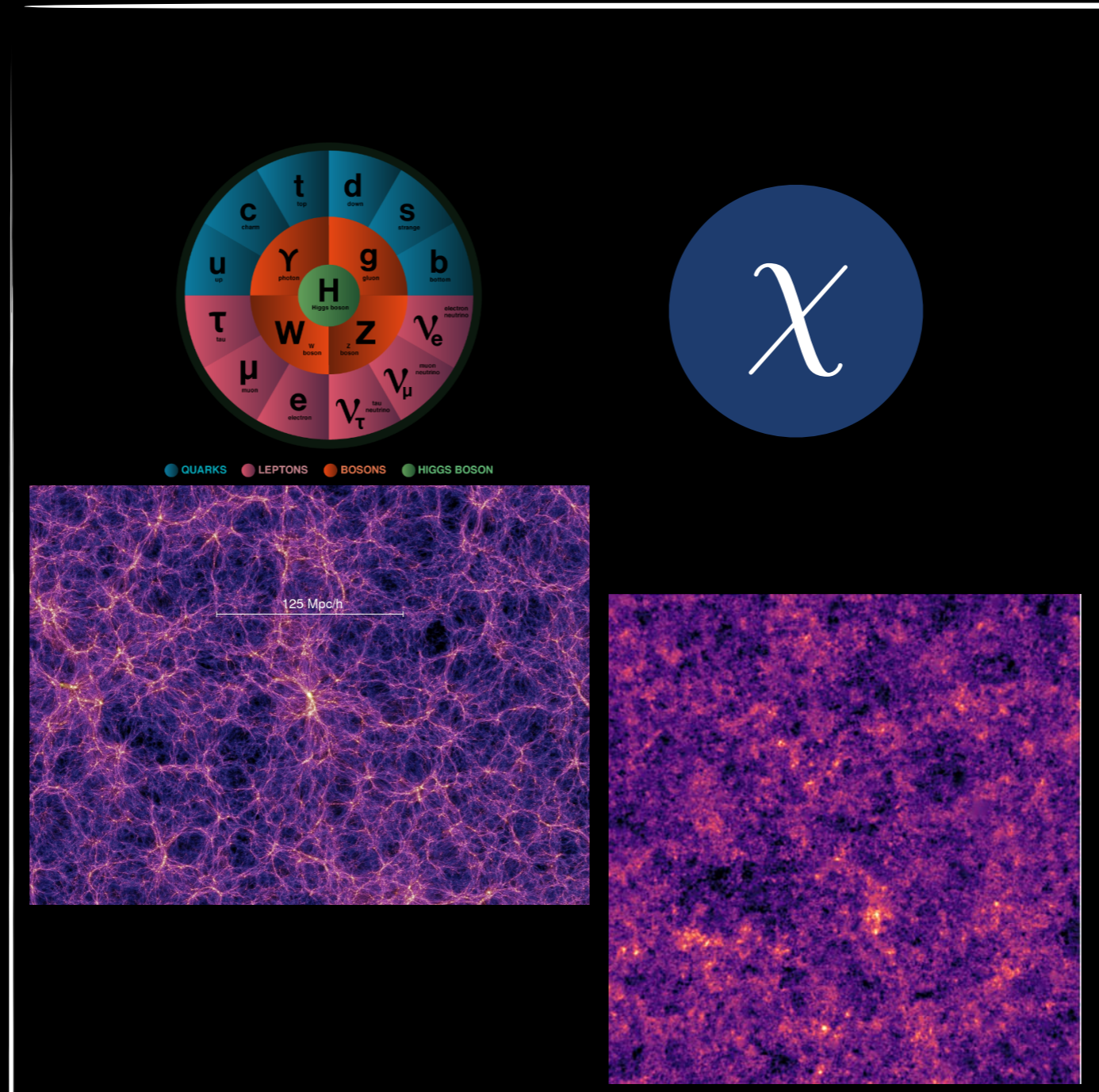
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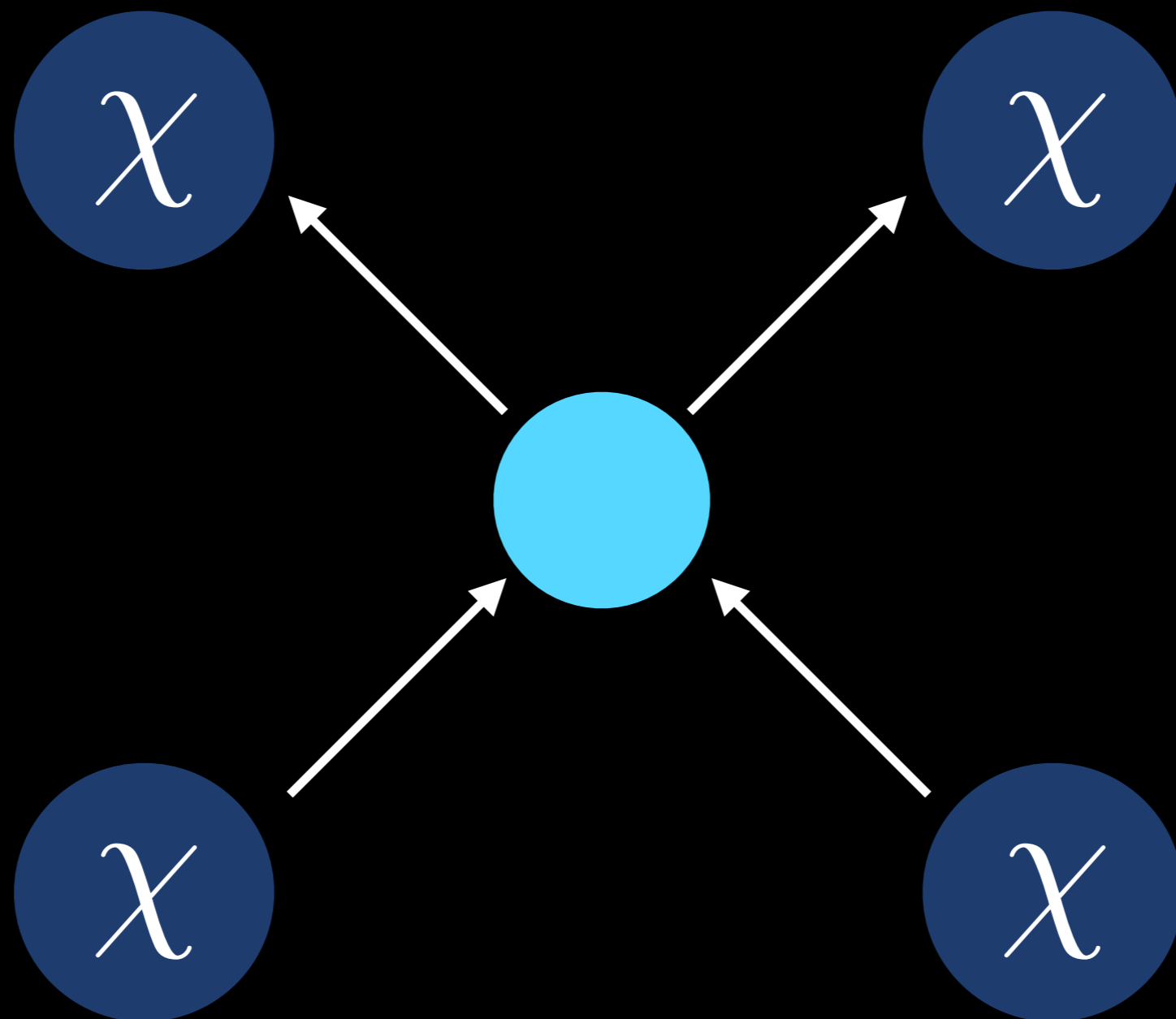
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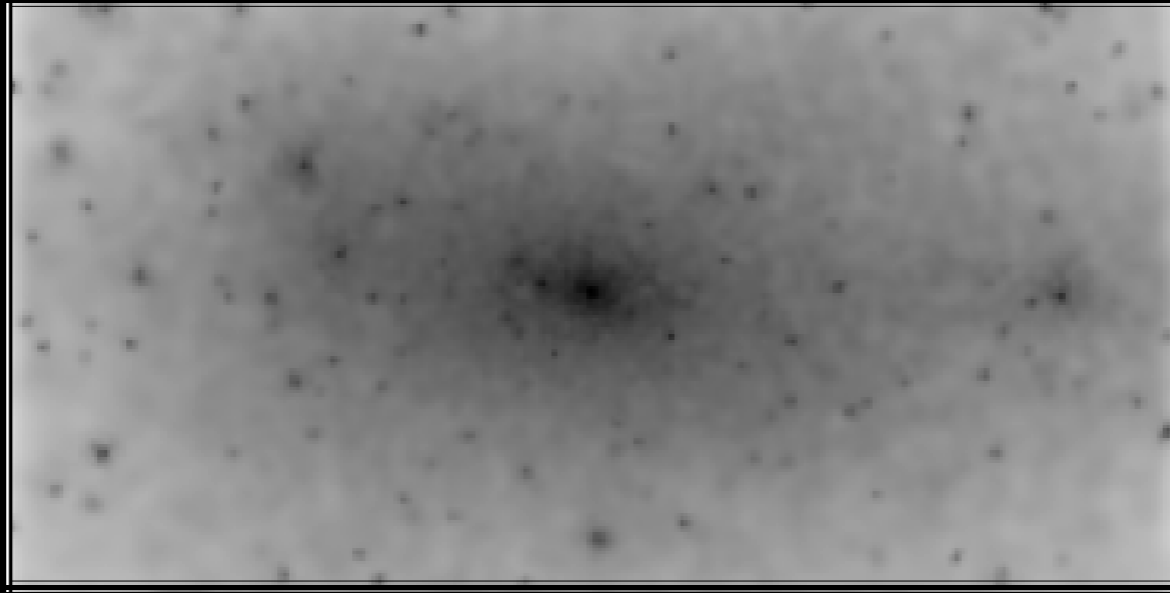


*ASTRONOMICAL OBSERVATIONS HAVE A UNIQUE VIEW
POINT ON THE SELF-INTERACTION*



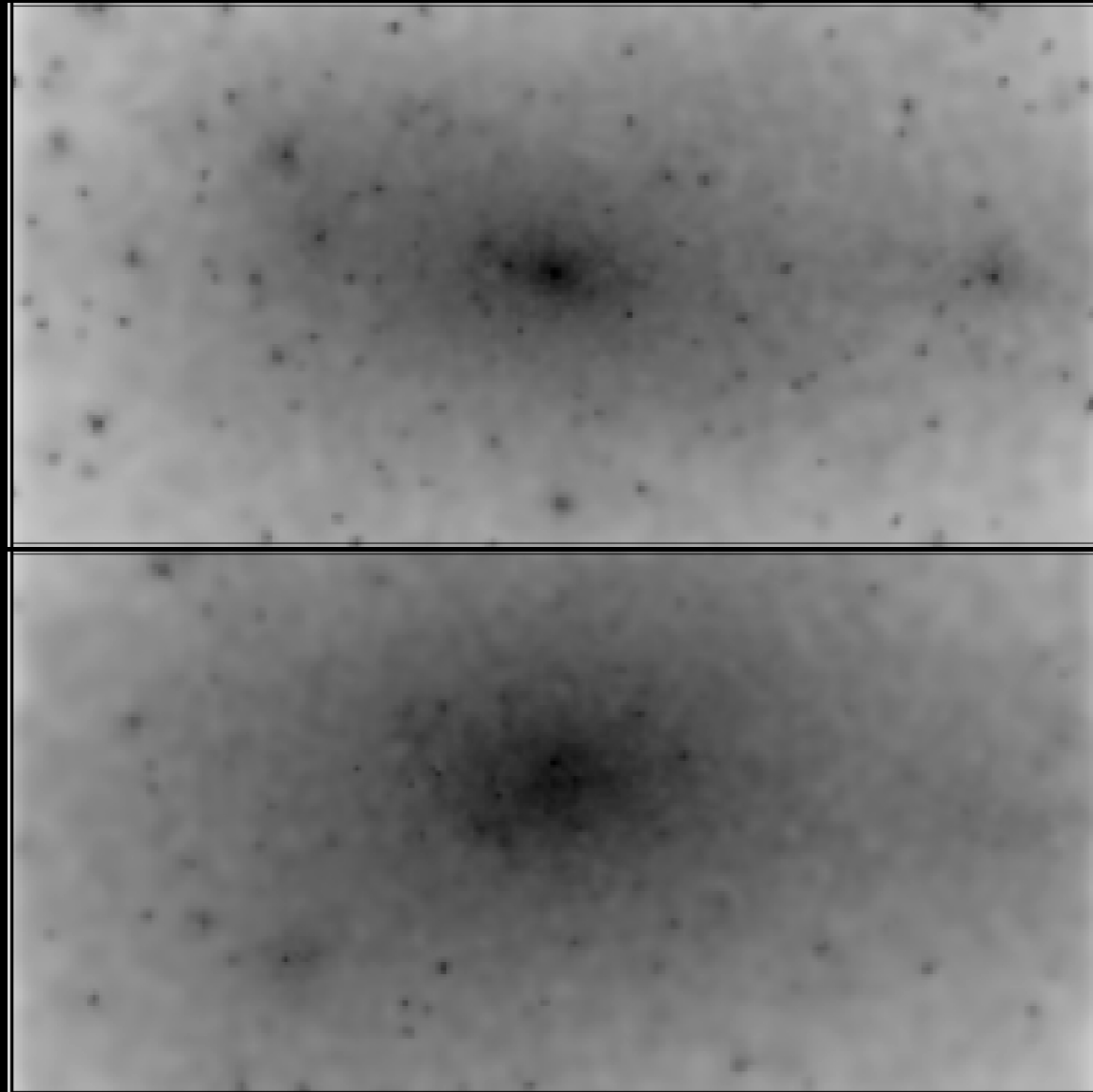
THE CLASSICAL WAY OF MEASURING THE SELF-INTERACTION

THE CLASSICAL WAY OF MEASURING THE SELF-INTERACTION



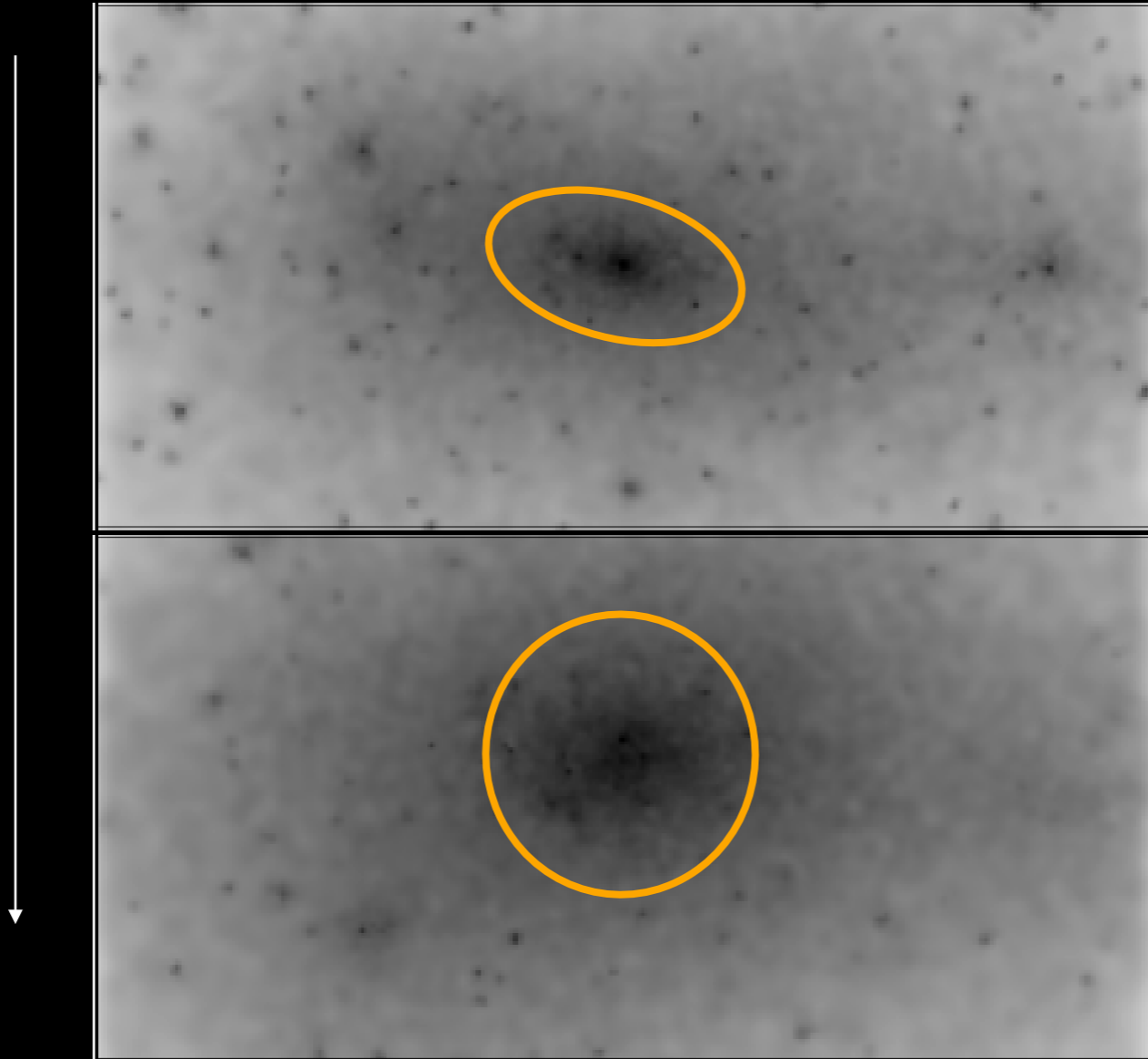
THE CLASSICAL WAY OF MEASURING THE SELF-INTERACTION

Increasing self-interaction



THE CLASSICAL WAY OF MEASURING THE SELF-INTERACTION

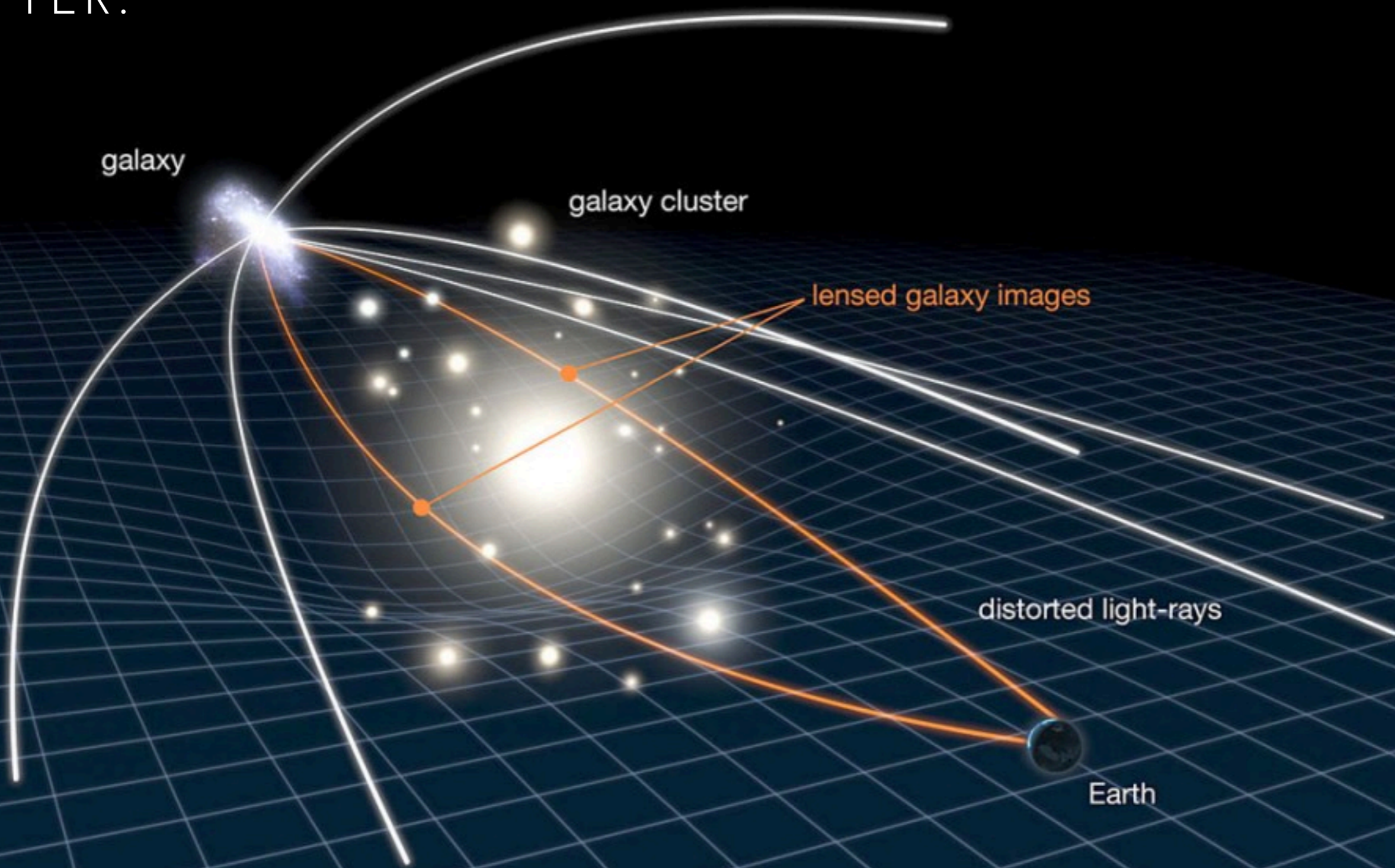
Increasing self-interaction



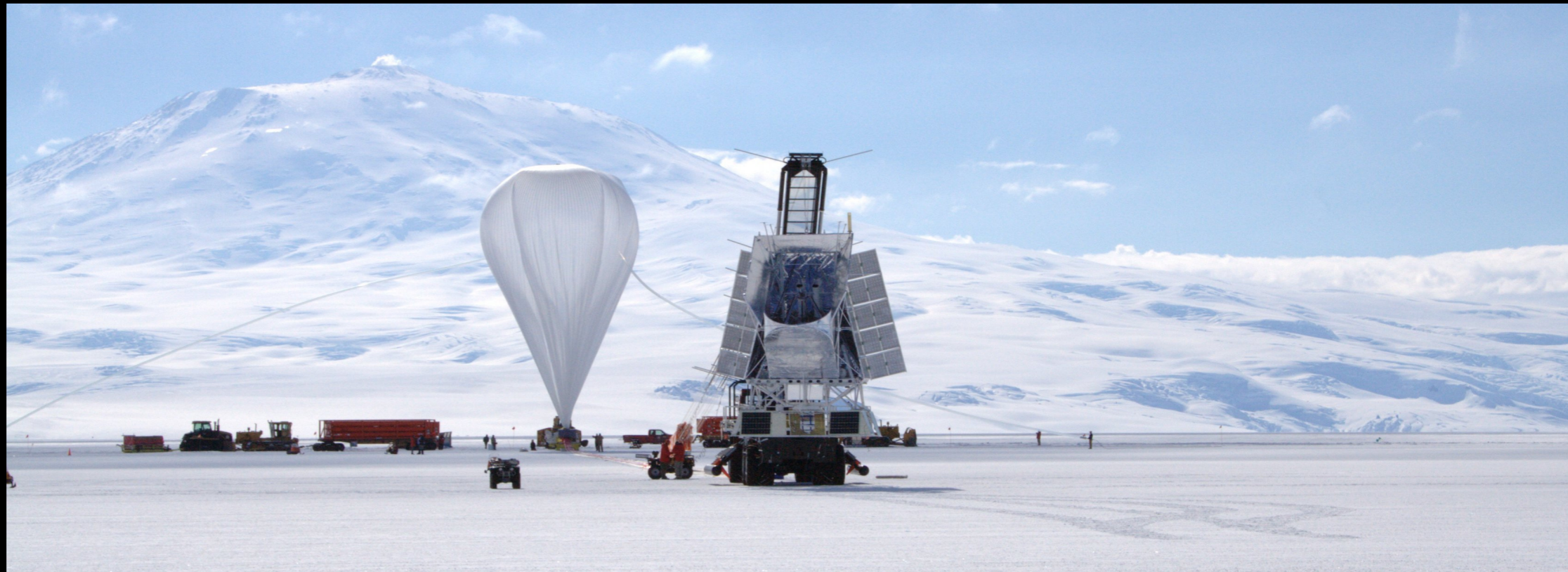
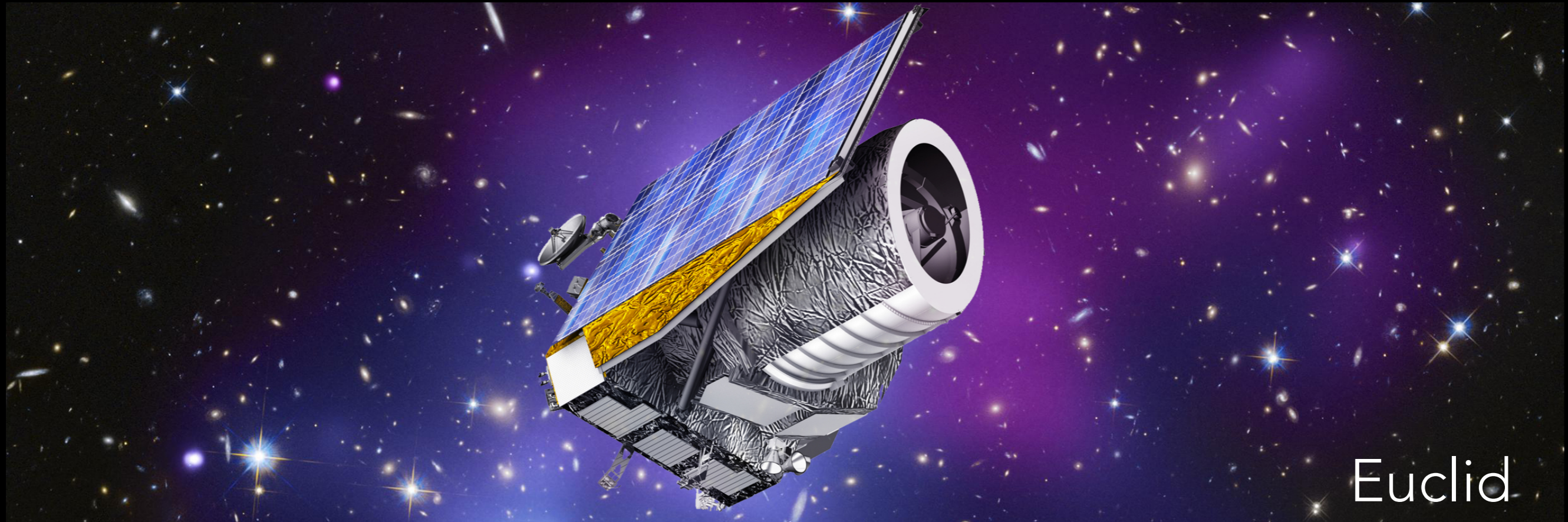
COMPARE THIS MODEL TO OBSERVATIONS

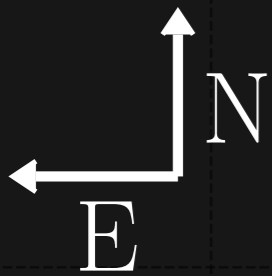


GRAVITATIONAL LENSING HELPS US TRACE THE DARK MATTER.

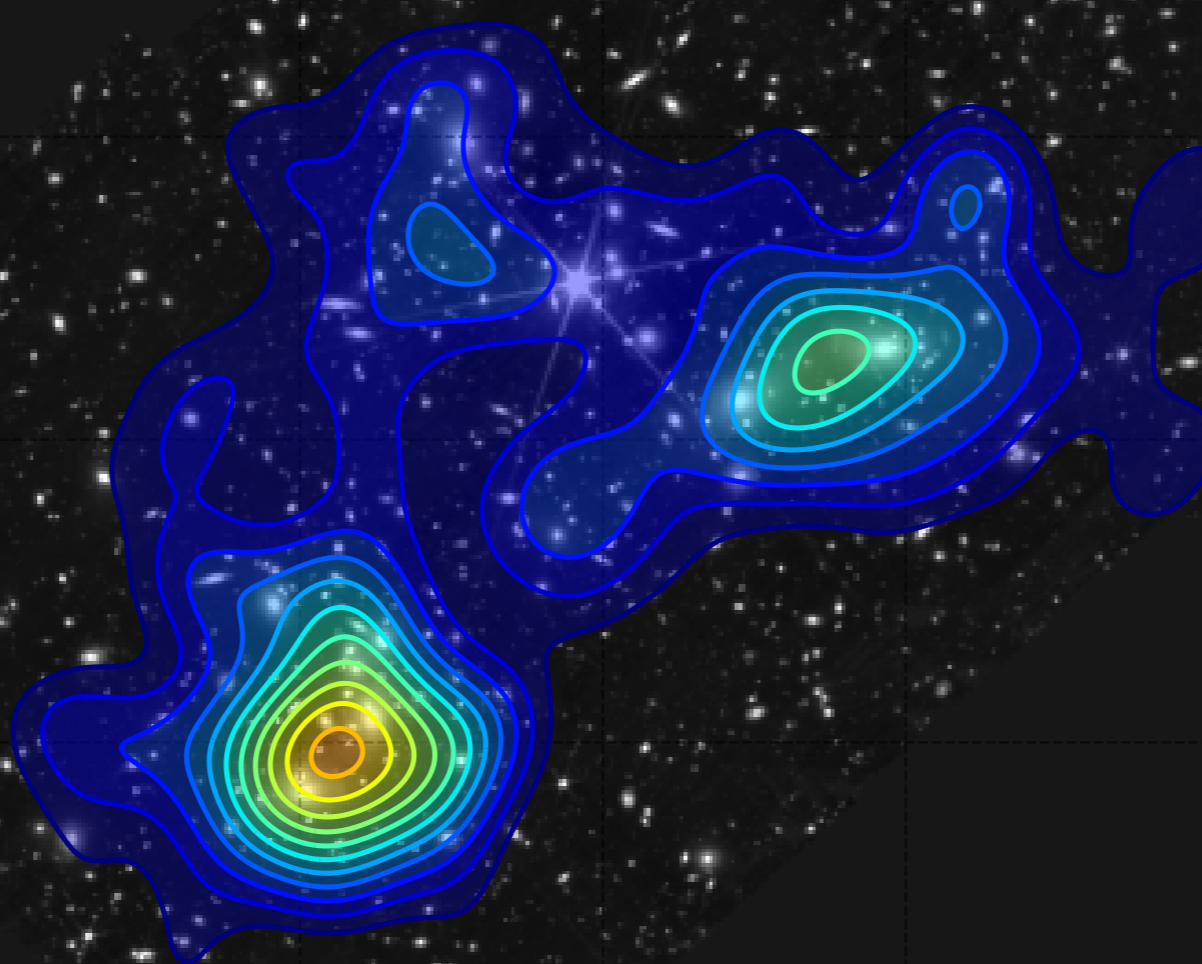
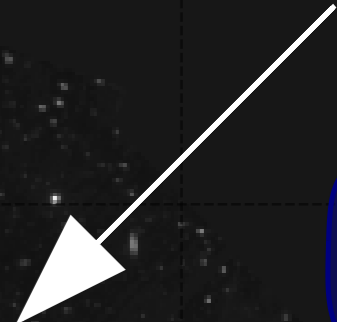


NEXT FIVE YEARS MANY
TELESCOPES WILL COME ONLINE.



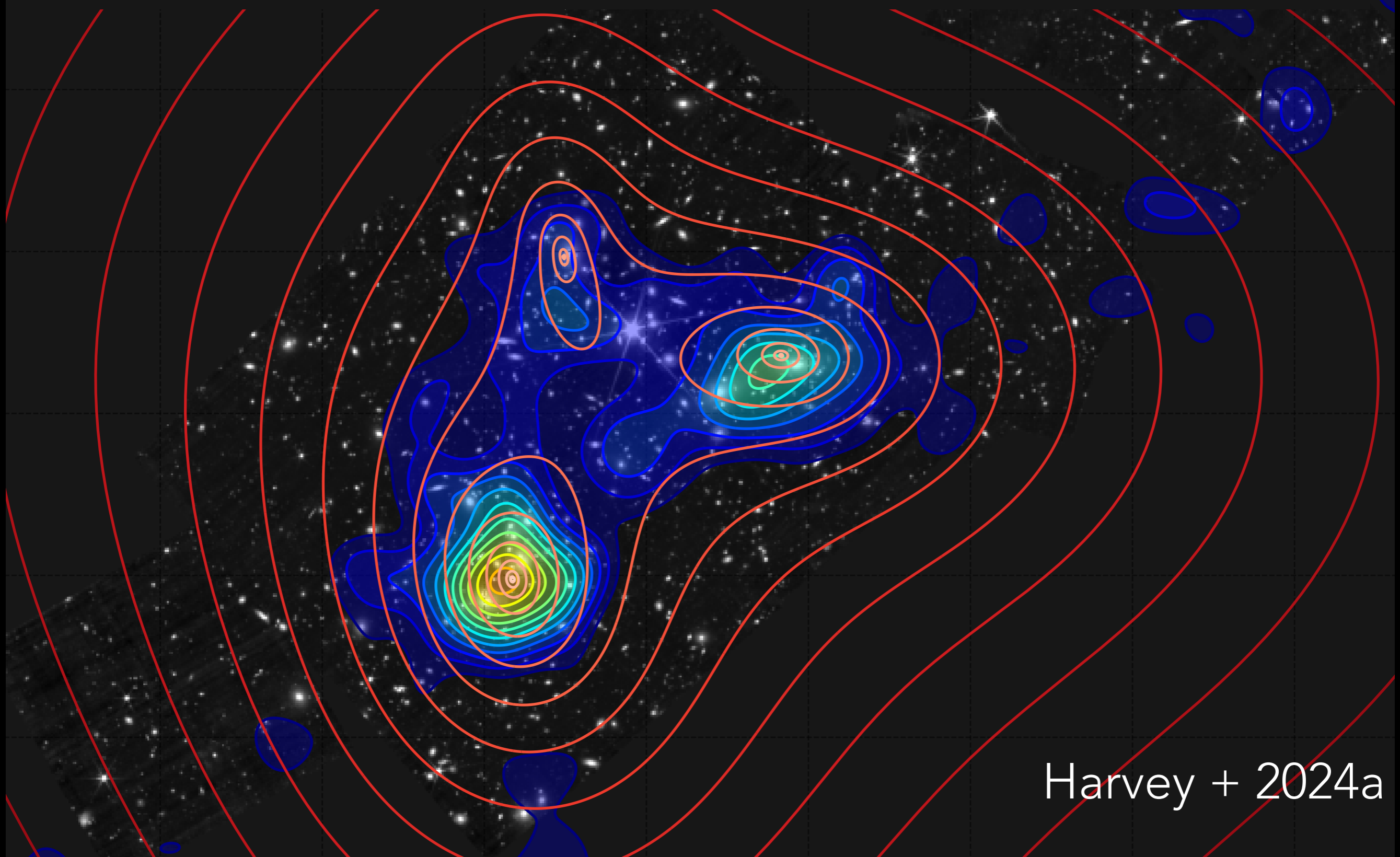


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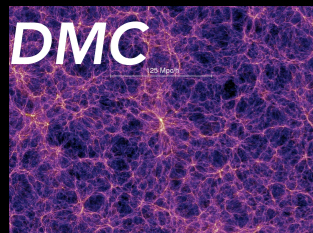
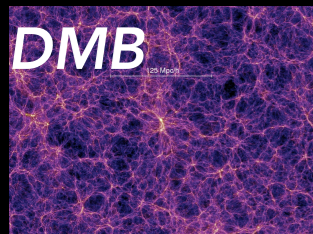
BUT INFORMATION CAN BE
LOST IN SIMPLIFICATION.



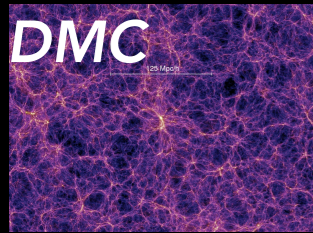
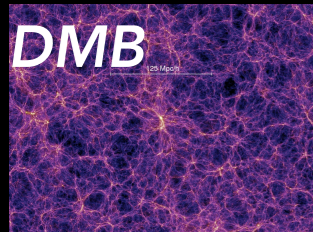
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DEEP NETS CAN HELP US AGNOSTICALLY PROBE
DARK MATTER WHILST SPEEDING UP THE PROCESS

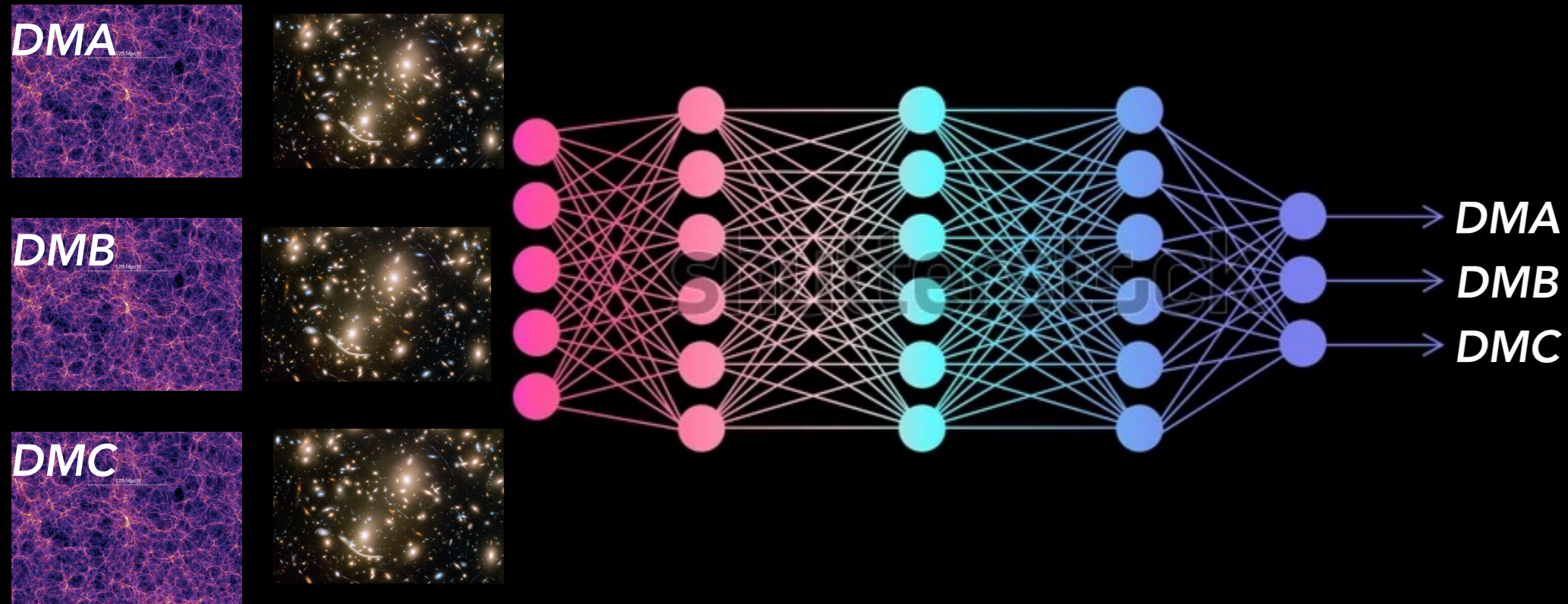
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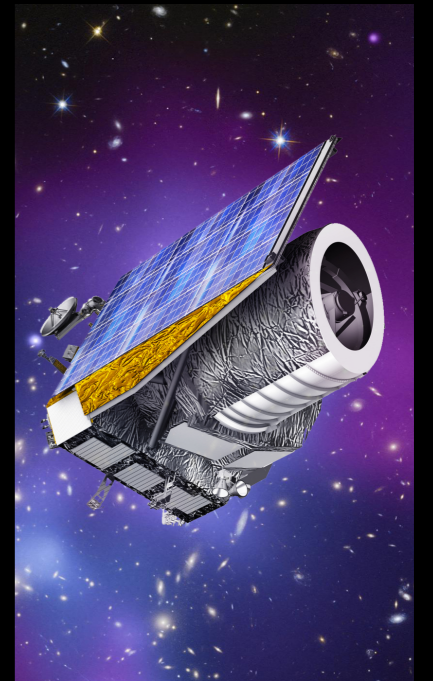
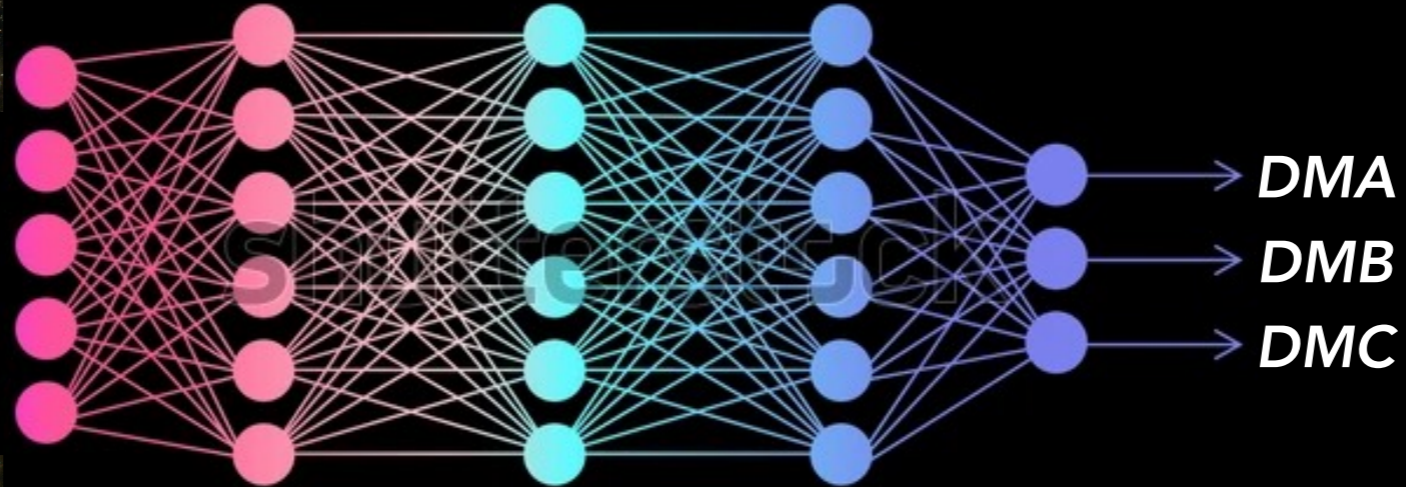
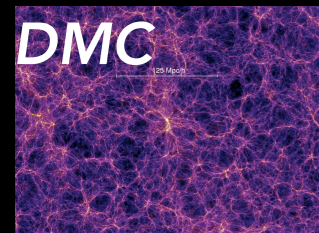
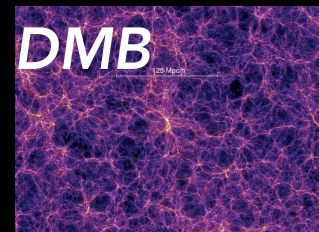
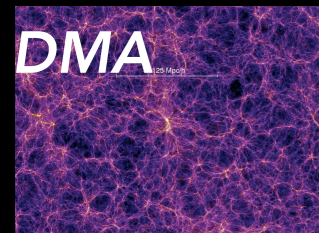
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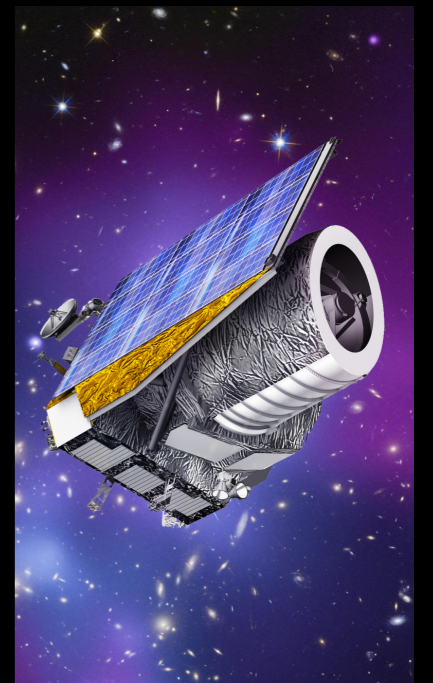
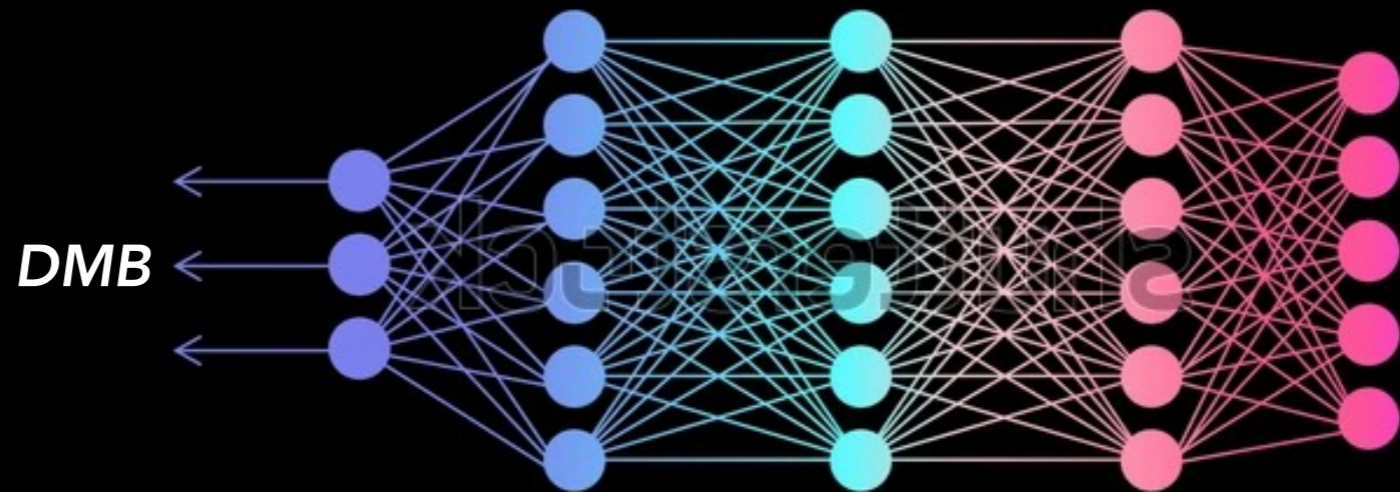
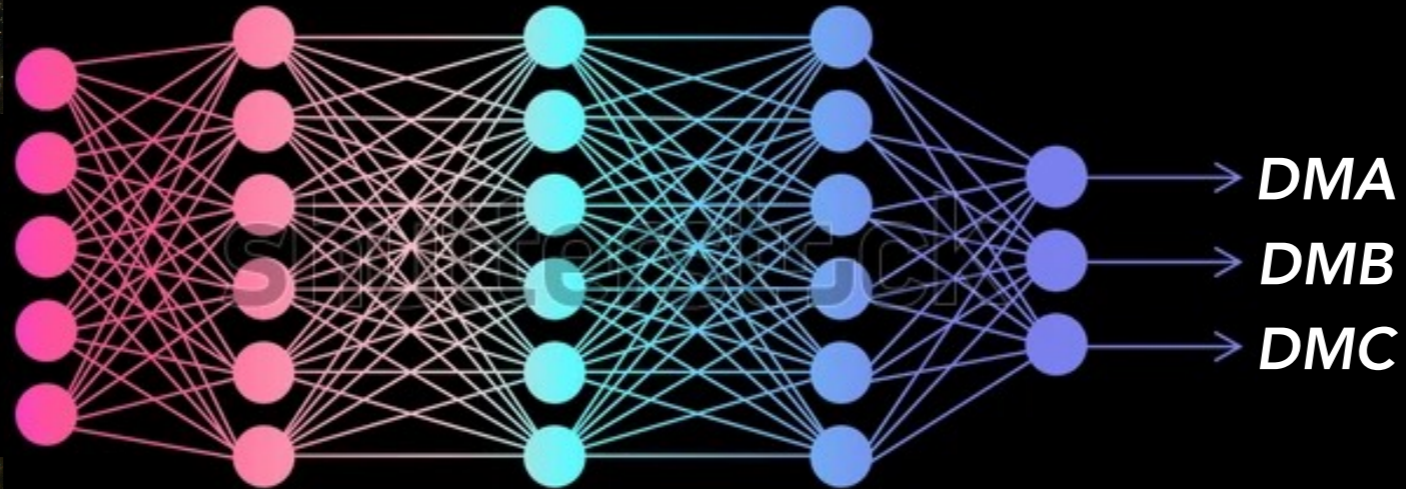
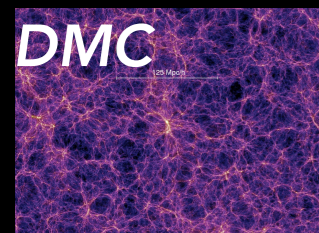
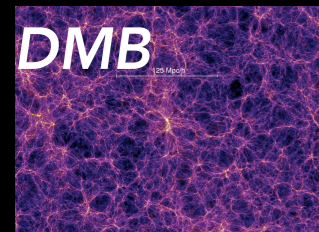
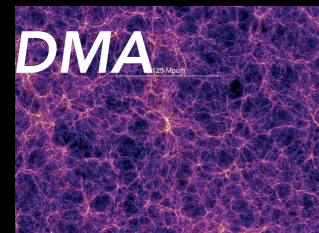
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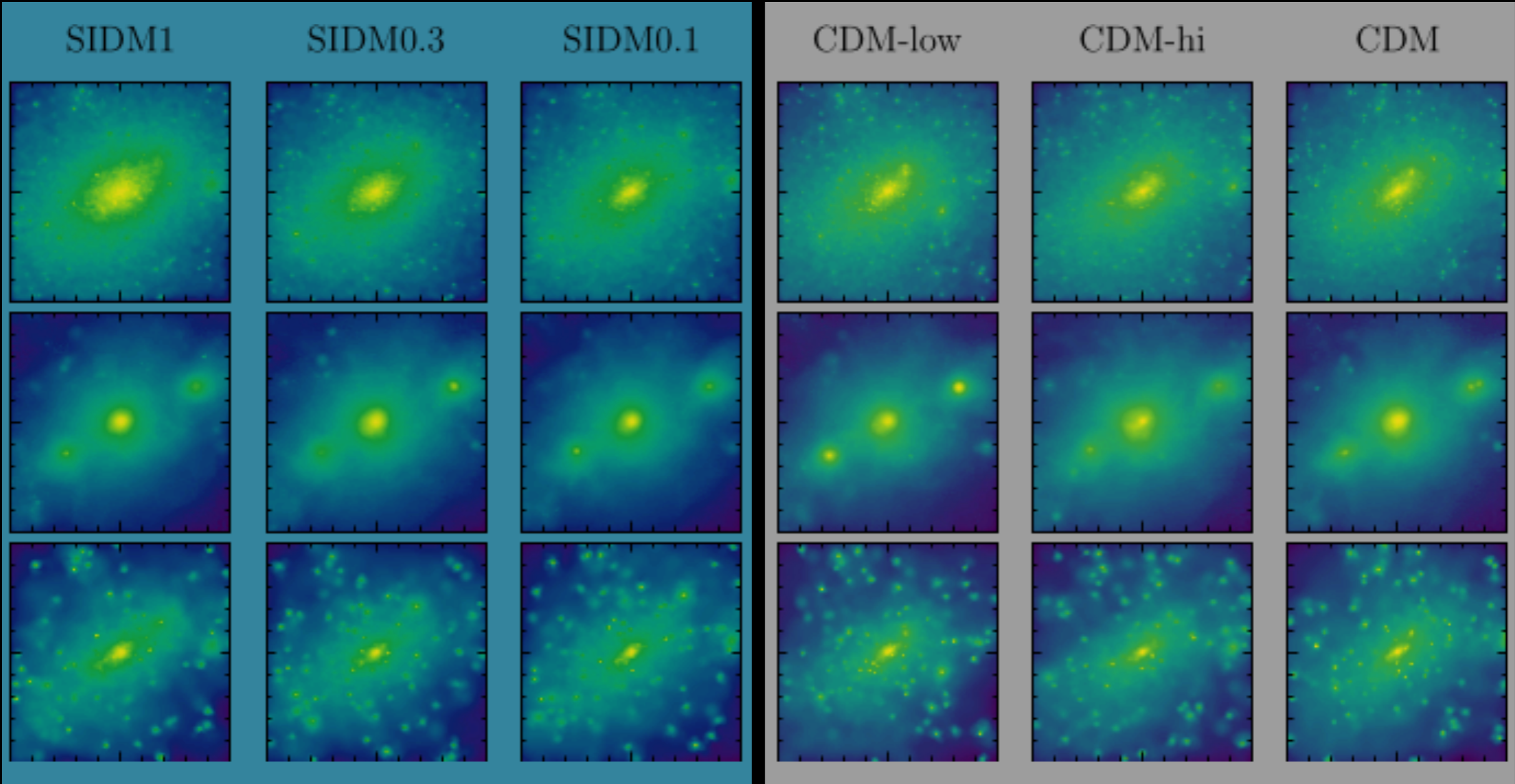


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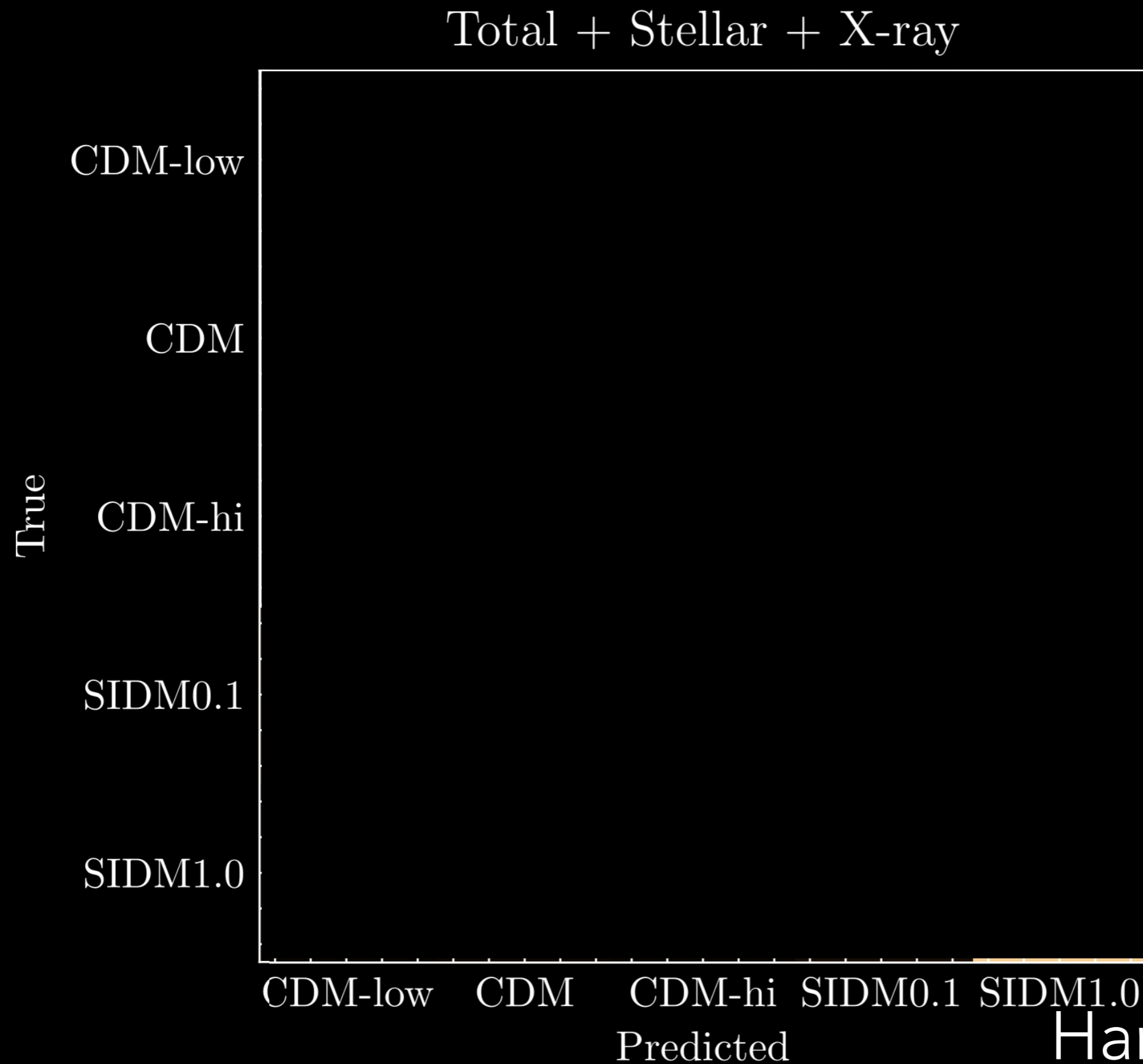
SIMULATING OUR TRAINING SET - BAHAMAS - SIDM

Different values of AGN feedback

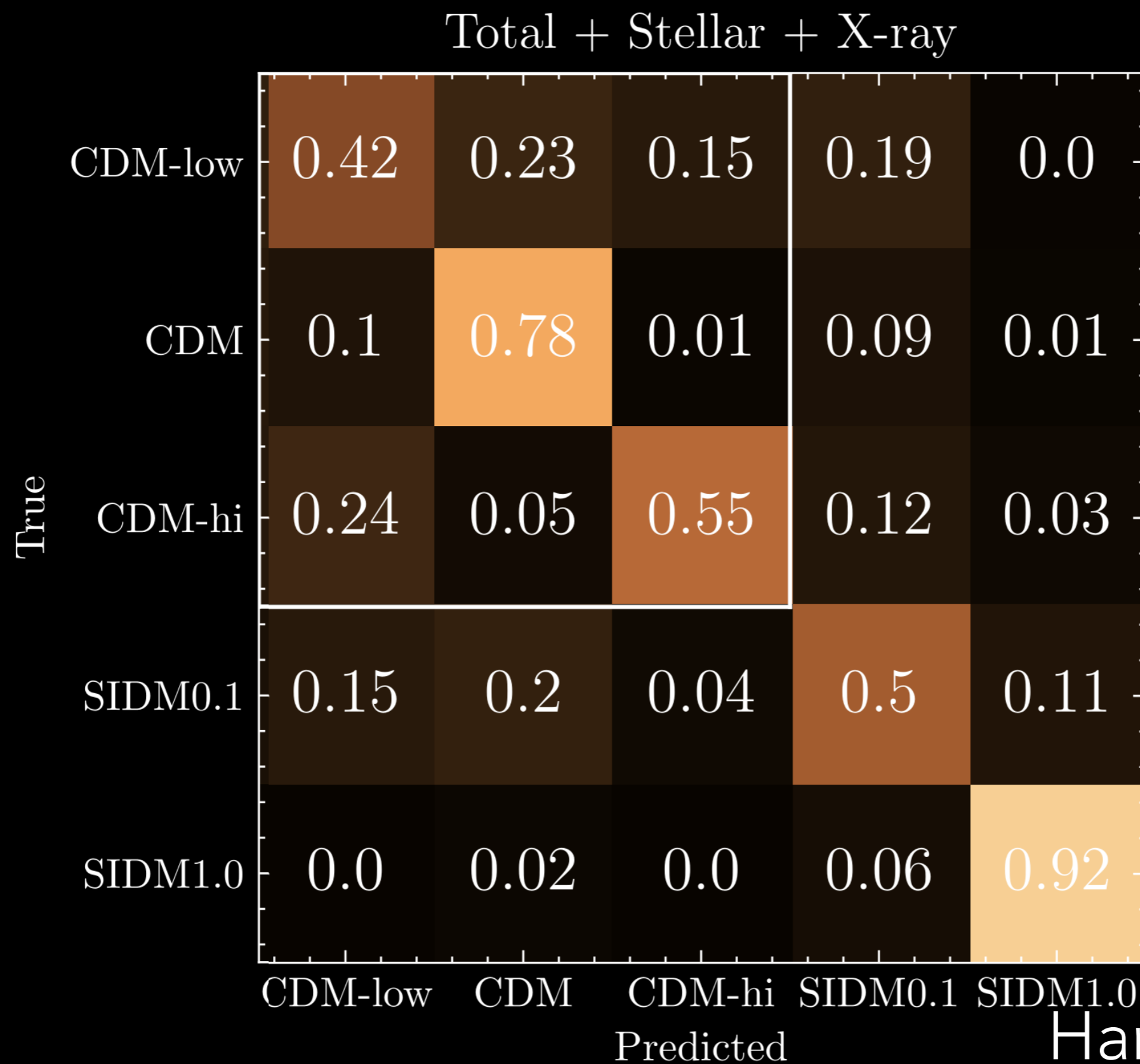


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The network performs very well compared to standard measures.

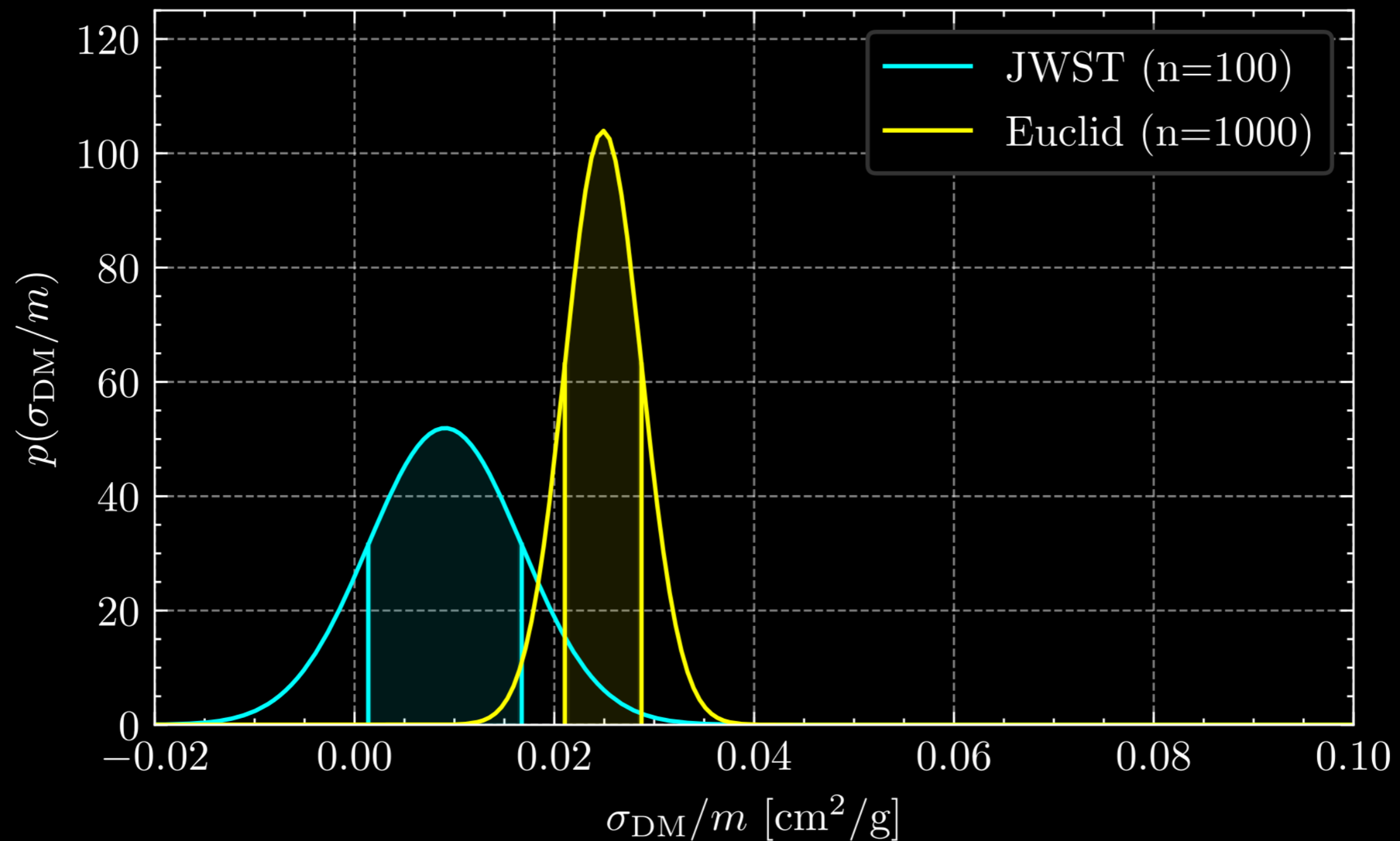


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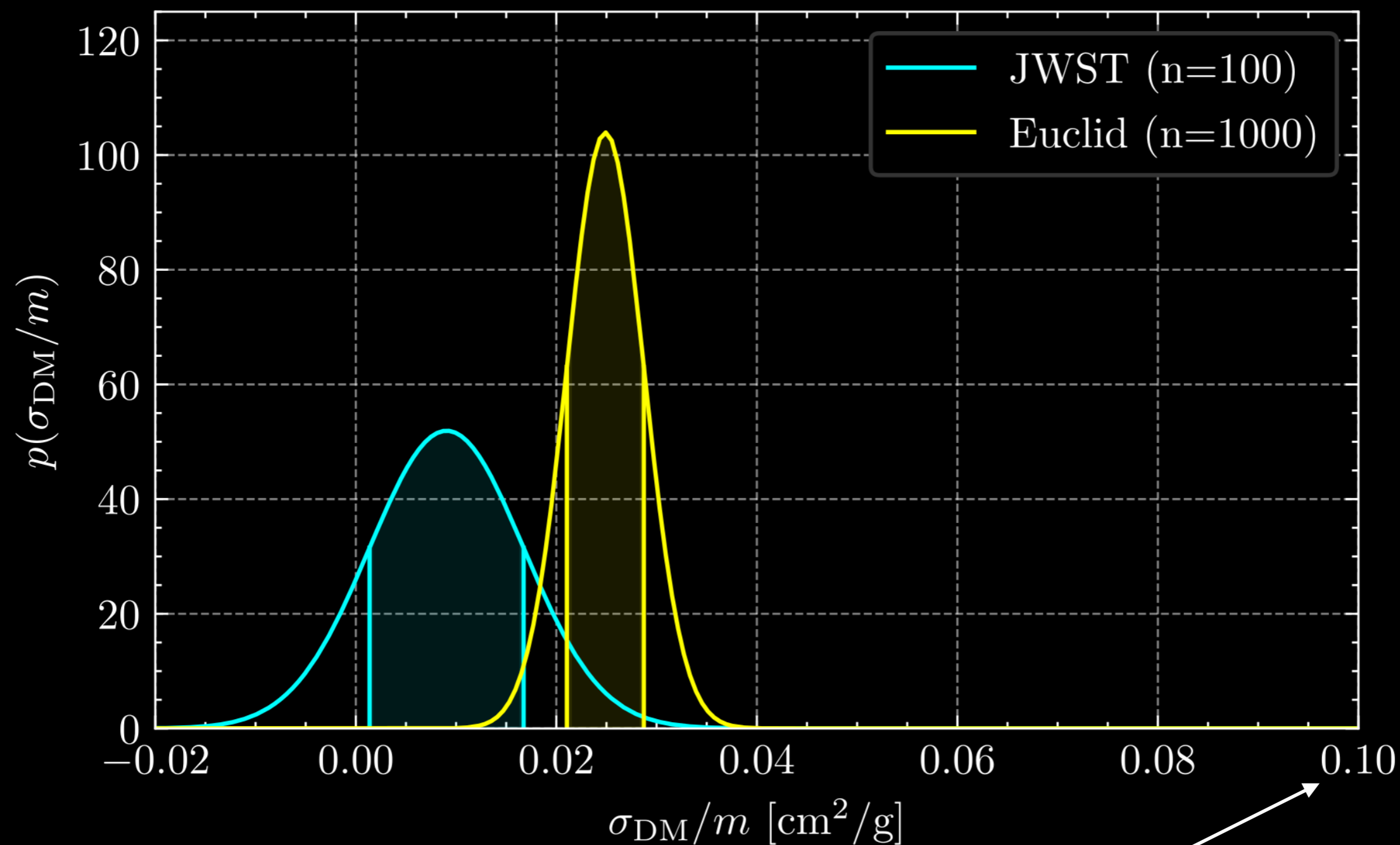


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Predictions after forward modelling on upcoming telescopes



Predictions after forward modelling on upcoming telescopes



Limit with classic methods

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DEEP LEARNING PRESENTS A NOVEL
WAY TO UNDERSTAND DARK MATTER
THAT COULD BREAK THE CURRENT
IMPASSE IN DARK MATTER RESEARCH

BUT WE MUST USE IT IN PARALLEL
WITH PHYSICS INFORMED METHODS
TO INSURE THAT WE PRODUCE
ROBUST AND TRANSPARENT RESULTS.

david.harvey@epfl.ch