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Dark matter and Gravitational Effects

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List item

`**Dark matter and Gravitational Effects**`

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The nature of dark matter (DM) is currently one of the most intriguing questions of fundamental physics. Yet, its existence is still debated, and relies on the observations of gravitational effects in large-scale structures and in cosmology. One of the most striking types of evidence of unexpected gravitational effects come from galaxies, and in particular spiral galaxies. In spiral galaxies, most of the visible mass is gathered in the budge and the disc. Using the Gauss'theorem, the velocity of stars v at the distance R from the galactic centre reads $v(R)=\sqrt{((GM(R))/R)}$
As a consequence, the velocity is expected to decrease as $v(R) \propto R\hat{}(1/2)$ most of spiral galaxies however the observed velocity far from the centre is approximately constant.
The most striking cases are the ones of strong gravitational lensing of distant galaxies behind a galaxy cluster, which appear under the form of several distorted images spread on the so-called Einstein circle. The angular radius of the Einstein circle is related to the mass which gave rise to light deflection through the formula.
$\varnothing\_E= \sqrt{(4GM/c\hat{}2 ((D\_s-D\_l))/(D\_s D\_L))}$

Gravitational lensing is therefore often used to weigh galaxy clusters, and numerous studies are consistent and tend to demonstrate that the visible mass represents only 10-20% of the total mass, similarly to the commonly found result in galaxies.

In the early universe when Matter starts gathering via gravitational collapse in the denser regions, forming large-scale structures in which galaxies also emerge. Two main effects which affected the structure formations are gravitational interaction attracts matter in the centres of masses, and the expansion of the Universe drives structures away from each other. the interplay between expansion and gravity and study the role of dark matter in this process is very important. Thus, there are various computer simulations which we run to visualise the formation of the universe. The standard cosmological model ΛCDM shows a remarkable agreement with all the observations from disparate scales. Finally, the combined results of are consistent with the large-scale structure data, and reveal that the ratio of baryonic mass over total matter mass is close to 15%, which is in agreement with the results at galaxy and galaxy cluster scales.

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