Few-Body Models in Dark Matter Problem

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Models of dark particle interaction with massive gravitational bodies are proposed and investigated. The models describe the resonant amplification of effective interaction between two massive bodies with large distances between them. The phenomenon is explained by the catalytic action of dark particle in this three-body system consisted of two heavy bodies and third body with small mass named here as the dark particle. Resonant amplification of the effective interaction between these two heavy bodies imitates the increase of their mass while their true gravitational mass remains unchanged. Such increased interaction leads to more pronounced gravitational lensing of bypassing light.

We considered three-body problems with different types of two body interaction between a dark particle and a massive heavy body. The first type of interaction was taken in the separable form, and second type was taken in the Breit-Wigner form. Both types gave the solutions in the analytical form that permitted simple analysis of three-body solutions. The gravitational interaction between two heavy bodies was taken in the ordinary form.

The starting point of the proposed approach is consideration of the main question: what is the reason for selectivity in the dark matter particle interactions with ordinary matter? More specifically, why and how the dark matter particles interact more intensively with massive bodies at very large distances, but demonstrate very little or no impact on bodies at relatively small astronomical distances? For instance, why within the solar system the observed action of dark particles is vanishing?

Here we can find an analogy with the catalytic action of an additional third particle at the interaction of two initial particles. For instance, the catalytic interactions are known in chemistry, and take place in the certain cases in the systems of several interacting nuclear particles.

In our astrophysical three-body models, we consider the gravitational interaction of at least two stellar objects (two gravitationally interacting bodies). At the same time, we assume that there is the third sort of matter (dark matter particles). This sort of matter gives the additional interaction between these two massive bodies, which can be considered in the frame of quantum scattering theory of three-body system.

Note, that for the two-body system we cannot obtain simultaneously the impulse of the system and the distance between the bodies. At the same time in the three-body system, it is possible to determine the impulse (or the energy) of dark particle and the distance between heavy bodies.

Another example demonstrates the appearance of new resonance states for a particle with a very small mass, which can arise in the system of two heavy bodies.