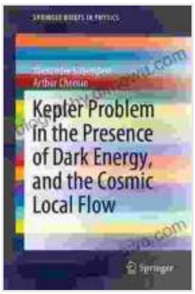
Kepler Problem In The Presence Of Dark Energy And The Cosmic Local Flow



Kepler Problem in the Presence of Dark Energy, and the Cosmic Local Flow (SpringerBriefs in Physics)

by Siân Morgan

★★★★★ 5 out of 5

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The Kepler problem is a classical problem in celestial mechanics that describes the motion of two point masses under the influence of their mutual gravitational attraction. It is named after Johannes Kepler, who first formulated the laws of planetary motion in the 17th century.

The Kepler problem has been extensively studied over the centuries, and many analytical and numerical methods have been developed to solve it. However, most of these methods assume that the two masses are isolated from the rest of the universe. In reality, however, all masses are subject to the influence of dark energy and the cosmic local flow.

Dark energy is a hypothetical form of energy that is believed to make up about 70% of the energy density of the universe. It is thought to be responsible for the accelerating expansion of the universe.

The cosmic local flow is a large-scale motion of galaxies in the local universe. It is thought to be caused by the gravitational pull of a nearby supercluster of galaxies.

The presence of dark energy and the cosmic local flow can significantly affect the motion of two masses that are interacting under the influence of gravity. In this book, we explore the Kepler problem in the presence of these two factors.

The Equations of Motion

The equations of motion for the Kepler problem in the presence of dark energy and the cosmic local flow are given by:

$$\begin{align}\frac{d^2\mathbf{r}_1}{dt^2}&= -\frac{Gm_2\mathbf{r}_1}{|\mathbf{r}_1|^3}+ \mathbf{a}_1^{\text{DE}}+ \mathbf{a}_1^{\text{CLF}}\\ \frac{d^2\mathbf{r}_2}{dt^2}&= -\frac{Gm_1\mathbf{r}_2}{|\mathbf{r}_2|^3}+ \mathbf{a}_2^{\text{DE}}+ \mathbf{a}_2^{\text{CLF}}\end{align}$$

where:

* $\mathbf{r}_1$ and $\mathbf{r}_2$ are the position vectors of the two masses * m_1 and m_2 are the masses of the two masses * G is the gravitational constant * $\mathbf{a}_1^{\text{DE}}$ and

$\mathbf{a}_2^{\text{DE}}$ are the accelerations of the two masses due to dark energy * $\mathbf{a}_1^{\text{CLF}}$ and $\mathbf{a}_2^{\text{CLF}}$ are the accelerations of the two masses due to the cosmic local flow

The accelerations due to dark energy and the cosmic local flow are given by:

$$\begin{align}\mathbf{a}_i^{\text{DE}}&= -H_0^2\Omega_{\text{DE}}\mathbf{r}_i \\ \mathbf{a}_i^{\text{CLF}}&= H_0\beta\mathbf{n}_i \end{align}$$

where:

* H_0 is the Hubble constant * Ω_{DE} is the dark energy density parameter * β is the cosmic local flow parameter * $\mathbf{n}_i$ is the unit vector pointing from the center of mass of the two masses to the center of mass of the nearby supercluster of galaxies

Methods of Solution

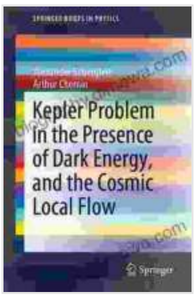
There are a number of different methods that can be used to solve the equations of motion for the Kepler problem in the presence of dark energy and the cosmic local flow. These methods include:

* Analytical methods * Numerical methods * Perturbation methods

Analytical methods are based on finding exact solutions to the equations of motion. However, these methods can be very difficult to apply in the presence of dark energy and the cosmic local flow.

Numerical methods are based on approximating the solutions to the equations of motion using a computer. These methods are more general than analytical methods, but they can be computationally expensive.

Perturbation methods are based on expanding the solutions to the equations of motion in a series of small



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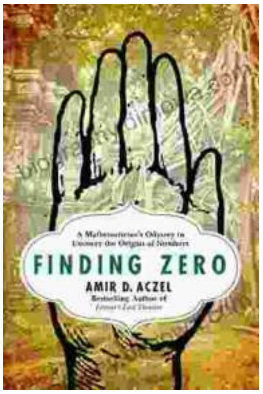

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