The Sun and planets

The Sun

On our stage, the role of main actor cannot but be conferred to the Sun, a star like many others in space, but very special for us because from the remains of its formation all the planets and the smaller bodies that rotate around it, and of which we are a part, have originated.
The Sun is so big that over 100 planets as big as Earth could be placed along its diameter. Its mass alone constitutes 99% of the total mass of the Solar System and it is capable of releasing, in the form of light and heat, an amount of energy equivalent to 1,000,000,000,000,000,000,000,000 100 W light bulbs, or 10,000 billion atom bombs, per second. The main motor resides in the Sun's core where every second hundreds of millions of tonnes of hydrogen atoms, the most abundant chemical element in the universe, fuse together producing energy.
The Sun is a gigantic sphere of gas at a very high temperature and in perfect equilibrium that does not collapse on itself and does not get dispersed in space thanks to the state of balance between the gravitational and pressure forces which are of equal intensity but act in opposite directions.
Being made of gas, our star does not have a solid surface; we can think of the Sun as an enormous onion made of concentric layers of gas: what we see from Earth is the outline of the outer shell called the photosphere. The phenomena that take place in this region can be viewed even with small instruments as long as they have adequate filters: in fact, one must remember never to stare directly at the Sun because its light is so intense that it would cause permanent eye damage. On observing the photosphere, one notices that it is not compact, but made up of many small cells. This structure, called granulation, is caused by convective motion: columns of hot gas coming from the centre of the Sun reach the surface and then sink towards the interior. Also in the photosphere, groups of sunspots can be observed. These areas appear darker than the surrounding area because within them the gas is cooler than average. Even though they look small on the Sun's surface, these structures are so big that they could contain five planets the size of the Earth. In contrast, faculae are areas that appear brighter because they are warmer than the surrounding gas. Above the photosphere lies the stellar atmosphere made up of two distinct areas known as the chromosphere and the corona, in which the gas is more rarefied. Even in these regions some phenomena can be observed, such as protuberances, gigantic columns of gas that rise almost perpendicularly to the Sun's surface and which form beautiful arch-shaped structures. From the corona, the Sun extends into space releasing a stream of elementary particles called solar wind. Since the particles it is made up of, basically electrons and protons, are very energetic, the solar wind is harmful to all forms of life. Fortunately, the Earth has adequate defences: due to its magnetic field, that envelops the Earth like a protective shell, it is able to deviate these currents of particles, preventing them from reaching the surface. Some, however, manage to escape and to penetrate the upper parts of our atmosphere, colliding with the gas molecules and exciting them. The consequences of these interactions constitute one of the most beautiful natural phenomena: the spectacular polar auroras.
Moreover, it is the Sun that establishes the extreme boundaries of the Solar System, referred to as the heliopause. In fact, the solar wind creates a bubble in the interstellar medium, a very rarefied gas that pervades our galaxy. The interstellar medium is dotted by other bubbles similar to the Sun's, proof that there are other stars that belong to as many solar systems that could be similar or very different from ours, just like the daisies in a meadow.

The planets

Though the Sun is the main actor, the planets are also protagonists, but an important fact must be highlighted: since the mass of the Sun alone makes up 99% of the mass of the entire Solar System, the planets are like crumbs respect to our star. In addition to this, these particles orbit around the Sun at enormous distances respect to their own size. A proportion could be calculated between the size of the Sun and that of Jupiter, the biggest planet in the Solar System and the distances between them could be scaled down by the same factor. If the Sun were the size of a grapefruit, then Jupiter would be the size of a grape about 100 metres away, the length of a football pitch. There is a void space between them, with the exception of some other "grapes", and darkness, because out in space it is absolutely dark, if one is not looking

directly at the Sun.
Since they are not stars, planets cannot produce their own light, but only reflect it. Some appear to be the brightest objects in the sky after the Moon and are visible even at dawn and dusk when the sky is not dark, the last to disappear when the Sun rises and the first to reappear when night falls.
Planets are often accompanied by satellites, or moons, bodies that rotate around them and with which they form a single structure that revolves around the Sun. Moreover, the bigger planets have a ring system, probably the remains of satellites that in ancient times disintegrated and that the force of gravity has kept suspended around the planet.
In the Solar System, planets have been classified in two categories: rocky planets and gas planets. There are four rocky planets and they form the inner Solar System: in order of their distance from the Sun, they are Mercury, Venus, Earth and Mars. They are called rocky planets because their surface is made up mainly of solid material and they are surrounded by a thin atmosphere respect to the size of the planet itself. Moreover, they have moderate sizes and few or no satellites.
The gas giants, instead, are part of the outer Solar System; they are Jupiter, Saturn, Uranus and Neptune. They are mainly made up of gas that becomes denser and denser as you move towards the centre. Some hypotheses claim that there is a very small solid nucleus at the centre. These planets have ring systems that can be more or less complex and bright and numerous small satellites that orbit around them.

Gravity and the planets' orbits

Most of the bodies of the Solar System revolve around the Sun in orbits that are not circular but elliptical and in which the Sun occupies one of the two foci (Kepler's First Law). In particular, planets move along orbits that are slightly eccentric, i.e. slightly squashed, and almost all on the same plane because of the mechanism with which they were created during the formation of our planetary system. Dwarf planets and minor bodies on the contrary are characterised by more elongated and inclined orbits.
All bodies in the Solar System move at different speeds depending on their distance from the Sun; faster when they are closer to the star, and slower when they are further away (Kepler's Second Law).
Moreover, as the distance increases so does the length of time taken to complete a revolution around the Sun (Kepler's Third Law); in fact, Mercury takes only 88 days while Neptune takes nearly 165 years.
The great force that keeps the Solar System together and prevents the single components from dispersing into space is gravity, a force generated by bodies simply because they have a mass. In fact, between any two bodies there exists a force of mutual attraction that is directly proportional to the product of their respective masses and inversely proportional to the square of the distance between them. Due to its mass, the Sun is the body that has the greatest gravitational influence on all the other components of the system that revolve around it; and following the same principle, satellites revolve around their parent planet. But planets influence each other too and influence the movement of minor bodies, even though this effect is greatly inferior to that of the Sun on each of them. For example, Neptune was discovered because Uranus's orbit was different from the predictions made on the basis of mathematical calculations; this difference was generated just by the gravitational pull of the outermost of the giant planets in the Solar System.
The orbits of the bodies in the Kuiper Belt are always disturbed by Neptune's gravitational force just as the asteroids within the main belt feel Jupiter's gravitational attraction. On Earth, the gravity of other bodies generates very different phenomena which are more or less well known to us; it is worth mentioning, for example, the ocean tides and the precession of the equinoxes, a long term variation of the inclination of the rotational axis.

The shape of things

A central force is a force whose direction depends only on the distance between the point of application and a fixed point, known as central point. Hence, in a central force field, the force vector in every point is parallel to half-lines extending in every direction from the origin. For this reason, a spherically symmetric field is originated.
Gravitational attraction is a central force. Its formula is as follows:

$$F=G(m1*m2)/(r_{12})^2$$

The only vector capable of giving a direction to the force is r, the distance between the masses taken into consideration. So, for example, in the absence of other factors, from the gravitational collapse of a cloud of gas and dust, spherical bodies are created, such as the stars and planets. Actually, we know that during the formation of a celestial body, the clouds of gas and dust rotate around their centre; as a consequence, the objects produced are not perfectly spherical, but slightly flattened at the poles as a result of the centrifugal force. The Earth, for example, is not perfectly spherical but is a rotating geoid: the radius at the Equator is about 20 km less than the radius at the Poles.