Nebular Theory Game

Summary

Students will understand the formation of planets and solar system bodies by playing this game.

Time Frame

1 class periods of 60 minutes each

Group Size

Large Groups

Materials

- post discussion questions worksheet (attached)
- dust particle cards / planetesimals (attached)

Background for Teachers

Time involved and size of clumps:

Simulations indicate that, in perhaps as little as 100,000 years accretion resulted in objects a few hundred kilometers across" (Chaison, 2008). It is thought that the formation of protoplanets from nebular dust grains required a few million years. Forces involved: Similar interstellar dust particles stick through electrostatic attraction; after clumps grow to a certain mass they gather materials to form planetesimals through the force of gravity.

Instructional Procedures

Introduction:

How do you think bodies in the Solar System formed. How do you think these different types of bodies came to be? Scientists think that in the beginning of its formation, our Solar System was a big cloud of gas and dust. Some event made it begin to spin, and it eventually spun down into a disk of matter swirling around our protosun (think of it as a baby Sun). As material moved around the protosun, dust grains in the disk collided with each other and started sticking together to form larger rocks. These rocks in turn collided with other rocks and either gravity held them together or they broke into smaller pieces, depending on the nature of the collision and the relative gravity of the individual rocks. Over the next few million years, these rocks combined into larger and larger bodies and eventually, formed the planets and other large bodies we have today. Evidence of these collisions is seen on the surface of the planetary bodies, including asteroids, in the form of craters left by the impacts. Have you ever seen dust in your home or in your bedroom? Have you ever seen clumps of dust--dust bunnies--under your bed? This is similar to what it was like in the early Solar System. The dust particles "accrete"--or gather together. In today's activity, we will actively model one of the theories called "Accretion" that describes how scientists think asteroids and planets formed.

The Activity:

This game is similar to "tag." When you tag a person they have to stay near you as you form an asteroid! The goal is to tag as many students as you can as the game progresses.

Each student will get one Interstellar Dust Card (attached) so that there are roughly equal numbers of types of grains (metallic, rocky, icy) represented in the class. The teacher will be the Sun and stand in the middle of a circle of students. Students will model interstellar dust particles, the dust grains around which matter began to accumulate in the early Solar System. There are three kinds of dust

grains. Students with red colored tags are silicates and rocky dust grains; those with blue colored tags are metallic dust grains; and the white colored tags indicate icy grains. Read the description of your type of dust grain on your role cards.

- Round 1
  You will jog (not run) in a counter clockwise circular path around the "Sun" which is in the center of the large open area. As you jog, you should keep your arms to your sides until you come close to another student. For the first part of the activity, we will model "sticky attraction." That is, you can tag and stick *only* to one like grain. For example, if one icy grain tags another icy grain, they form a pair and can now extend their arms in order to tag another icy grain. An icy grain, however, cannot tag a metallic or a rocky grain. Students who pair up are called clumps. The force at work in Round 1, where like grains can attract and stick to like grains is electrostatic attraction.
- Round 2
  Now your clumps may tag other like grains (one or more) and the group will stay together and can try to tag others. At the end of this round you may form groups of various sizes. If you become part of a group that has four or more students, you will represent *planetesimals*. You now represent the first phase of the Nebular Theory of Solar System formation-- from interstellar dust particles to planetesimals. Planetesimals are larger than "clumps" but *each planetesimal is made of the same type of material*. Some are made of rocky materials, some are made of metallic materials, and others are made of icy materials. You were also traveling at relatively low velocities so that when you collided with the same type of dust particles you 'stuck' and didn't just bounce off them. If you were real planetesimal, you would have accumulated enough dust particles to be the size of a small moon.
- Round 3
  Those groups who formed planetesimals can now tag and stick to any other type of grain. You have formed large enough groups that you can use your gravitational force (extended reach) to attract other dust particles or other planetesimals. At the end of this round our two largest groups will be called protoplanets You have just modeled the second phase of the Nebular Theory of Solar System formation--where planetesimals grew in size to form protoplanets using *gravitational accretion*.

Bibliography

Lesson Design by Jordan School District Teachers and Staff.

Authors

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