Welcome students in this session we

will be doing Earth dynamics and

structural geology GEC103 Unit 1.

Module 3 origin of the solar system. The

planetesimals hypothesis will be covered in

two modules, so this is the part one.

Through the session we will be going through the introduction,

we will identify certain regularities that are observed in

the solar system and then we will know about the solar

nebular theory. By the end of this lecture you will be able to

explain the nebular theory for the origin of the solar system.

Introduction: Our solar system,which is a part of the Milky

Way Galaxy, consist of the Sun,8 planets, one dwarf planet-

Pluto, 101 known moons, (though this figure is constantly changing), a

huge number of asteroids that lie between a belt between Mars

and Jupiter, and millions of comets and meteorites.

Along with this, we also have planetary dust and gases.

In the quest of understanding the origin of solar system, we

are constantly making new observations and we're now in a

position that we have identified certain regularities that are

observed in the solar system.

These regularities are clubbed into four categories by Ter Haar.

orbital regularity.

A. All planets have almost circular orbits and they rotate around the sun. The orbits lie in the same plane. The direction of revolution for all planets is seen. B distance regularality.

The various bodies in the solar system are at different distance from the sun.

There is an orderly arrangement within this. There is a major discontinuity in the distance, mass and density between the inner planets in the outer planets. That is, differentiation of planets. The formation of 1 set of planets with higher density and the other set of lower density is a significant feature of our solar system.

The distribution of angular momentum. This is given by the Formula V.= mvr. Where V is the angular momentum and small m is the mass of the rotating body. v is the velocity and r is the radius. It is observed that sun accounts for less than 2% of the

total angular momentum of the system, in spite of having 99%

of the mass of the system.

Most of the theories that were proposed fail to explain this

particular aspect

So therefore, any theory that is proposed for the origin of

Solar System has to address all these regularities and

give a satisfactory explanation.

Many scientific theories have been proposed in this

regards. They have been accepted, modified and

discarded, but as of today, the Solar nebula

theory or the Planetesimals hypothesis

is the best known one.

This involves collapse of the interstellar material to a

counterclockwise rotating disk,in which is concentrated about 90%

of the material in the central

part. This concentrated central part is what forms the embryonic

sun. Around the embryonic sun swirled a rotating cloud of

material which is referred to as the solar nebula.

The planet Moon asteroid and comet form from the material in

the flat and outer part of this disk, this outer part.

Which did not get incorporated in the sun or

the embryonic sun is referred to as the protoplanetary

disk.

The disc in which the solar System formed already contained

92 elements. Some as isolated atoms, while some as molecules.

Material of the protoplanetary

disk. Geologists divide the material from these atoms and

molecules into two classes,1. volatile material and

2. the refractive material.

Volatile materials such as hydrogen, helium, methane,

ammonia, water and carbon dioxide are those material

that are seen as gases at earth's surface conditions.

Beyond a certain distance in the space called the ‘Frost

Line’, these volatiles condenses into ice.

Reflective material are those that melt only at high

temperatures. And they condense to form small soot size

particles of dust.

As the proto sun began to form, the inner part of the disk

became hotter. Causing the volatiles to evaporate and drift

away in the outer portions of

the disk. Thus the inner part of the disk ended up consisting

predominantly of refractory dust, whereas the outer portion

accumulated large quantities of more volatile material and ice.

Formation of the planetesimals, protoplanets, and planets. The protoplanetary disk evolved into a series of concentric rings in response to gravity.

The material surrounding the ring began to clump and bind together due to gravity and electrical attraction by colliding with one another.Eventually enough blocks coalesced to form planetesimals (Bodies whose diameter exceeds 1 kilometer). Because of their mass, the planetesimals exerted enough gravity to attract other planetesimals in their direction. Planetesimals sucked in small pieces of dust and ice as well.

They sucked in all the material that was available in their orbit and in the process they grew larger and larger.

Eventually they grew into protoplanets. Protoplanets were the size of the current planets that we see today.

Once a protoplanet succeeds in incorporating virtually all the debris within its orbit, it becomes a full fledged planet.

Fragments of material that were not

incorporated in the planet remain today as

asteroids and comets.

Differentiation within the

planet. When planetesimals started to form, they had fairly

homogeneous composition of material, but large

planetesimals did not stay homogeneous for long because they

started to heat up.

The heat came from 3 primary sources, one: the heat caused by

collisions. Two: the heat produced when matters squeezed

into smaller volumes, and three: the heat from the radioactive

decay of elements.

In bodies whose temperature rose

sufficiently caused internal melting. Denser iron alloy,

separated out and sank into the center of the body. Where as the

lighter rocky materials remained in the shell surrounding the

center. This process is referred to as 'Differentiation'.

This is how protoplanets and large planetesimals developed

internal layering by the process of differentiation.

Summary:Certain regularities have been identified and they need to

be explained satisfactorily by any theory on the origin of the

Earth. These regularities are

distance regularities, differentiation of

planets. Distribution of angular momentum.

Solar nebula theory for the origin of Solar System is the

most widely accepted one. It involves the condensation and

collapse of interstellar material in spiral arm of the

Milky Way Galaxy to form the embryonic sun and the

protoplanetary disk. Geologists divide the material formed from

these atoms and molecules into two classes, volatile and

refractory material. The protoplanetary disk evolved into

a series of concentric rings in response to gravity.

The material of the surrounding rings began to clump and bind

together due to gravity, and

electrical attraction. Blocks coalesced to form planetesimals,

and these grew in merge to form

protoplanets. Once protoplanet succeeded in incorporating all

that debris that came in its orbit, it became a full fledged

planet. These are the references that were used in

this session. Thank you.