Science Unit: ***Space***

Lesson 3: ***A Peek Into the Lives of Stars!***

School year:	2006/2007
Developed for:	Sexsmith Elementary School, Vancouver School District
Developed by:	Luana Avila (scientist), Jeanette Mumford and Mary Cotrell (teachers)
Grade level:	Presented to grades 2 and 3, appropriate for grades 2-6 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes

Objectives

1. Students will be able to describe the ingredients needed for a star to form
2. Students will be able to recognize names of the stages of a star's lifecycle
3. Students will be able to place the star lifecycle in the correct order

Background Information

When the universe was created, all the energy and matter began expanding from that single dense point. All this matter went flying off and after colliding and forming atoms; it slowed down and formed clusters of atoms, mostly gases like Helium and Hydrogen. These clusters contain gases and dust and they are very extensive, covering an area of millions of kilometers square. The entire cluster is called a nebula. Nebulas are the beginnings are stars.

A star starts to form when an explosion happens nearby a nebula. Before the explosion, the temperature of the nebula is really cold, so the dust and gases are moving very slowly. When the explosion shockwaves hit the nebula it acquires energy, sending the dust and gases into motion, but the slowness of the nebula particles allow gravity to clump them together. These large clumps are called protostars. The protostars are very large and have a faint glow from the gravitational energy released, but these are not hot enough to produce nuclear energy. The protostars continue on getting bigger, as dust particles and smaller clumps become attracted by the gravity the protostar generates and collide with it. This increased density and mass will make the protostar's core hot enough to fuse nuclei, converting hydrogen atoms into helium (a.k.a. a nuclear fusion reaction!). At this stage the protostar, the young star, becomes a star. The gravitational collapse will continue until the internal pressure and the heat, equals the force of gravity. The star is now in equilibrium, because the force pulling in equals the force pushing out. Most stars will spend 90% of their lifecycles at this stage. Our sun, for example, is currently a star in equilibrium and it has enough hydrogen to last another 5 billion years.

Once most of the hydrogen is converted into helium the star begins to die. The abundant helium in the core of the star becomes compressed and pushes the remaining hydrogen to the edges of the inner core of the star, causing the inner core to swell and the hydrogen to fuse faster. The rapid expansion of the star outstrips the luminosity produced by the fast fusing hydrogen, so the star begins to cool down and its appearance becomes reddish. This stage is called the Red Giant. The core of the Red Giant heats up because of the gravitational pressure making possible the conversion of helium into other atoms such as iron and carbon. When the core has gained so much mass that it cannot withstand its own gravity, it implodes. The neutrons in the core halt the implosion, turning it into an explosion, the supernova explosion. Depending on the initial size of the star the left-over core can become a White dwarf, for a small star, a Neutron star for a medium sized star or a black hole for a large star.

The lifecycle is completed when the shockwaves from the supernova explosion hit a nearby nebula restarting the cycle by creating a new star.

Vocabulary

Nebula:	The large cloud of gas and dust that will give rise to a star
Gravity:	The force of attraction between particles or objects that occurs because of their mass
Protostar:	The young stage of star, a star before it shines or produce heat from nuclear reactions
Hydrogen	The gas that fuses in a nuclear reaction to form Helium and produce heat
Helium:	A stable gas that is formed after 2 Hydrogen atoms fuse, found in abundance in old stars
Red Giant:	The dying stage of a star, when almost all the hydrogen has been converted to helium
Supernova:	The explosion of a dying star when the internal gas pressure exceeds the force of gravity
Black Hole:	The remnant of a very large star after it explodes. Has very strong gravity, such that not even light can escape. This is also known as a QUASAR.
Neutron Star:	The remnant of a medium to large sized star after it explodes. It is also known as a PULSAR because it emits pulses of high-energy radiation
White Dwarf:	The remnant of a small star after it explodes.

Materials for this lesson

- Jars with tight fitting lids
- Flour
- Water
- Sheets of paper to make a flipbook

Star lifecycle images are at the end of this lesson plan.

In the Classroom

Introductory Discussion (Hook)

1. Review the material learned up to this lesson – especially remind students about gravity.
2. Tell the students today we will be learning about stars – ask if they know about any star and write their ideas on a post-it and place it on the board.
    - Do you know the name or anything about a star?
    - What is the star that is closest to Earth?
    - Why do you think stars shine?
    - What is the shape of a star?
    - What is inside a star?
3. Tell them that today we will address some of their hypotheses and try to answer some of the curiosity they might express.
4. Get the students discussing the different aspects of stars then guide them to wonder how stars are born.

- What are the ingredients to make a star? (dust, gas, gravity and nearby explosion)
- How do these ingredients come together to form a star?

5. Ask them how could we test our hypothesis that those are the ingredients for a star?
   - Reintroduce the idea of a model – we cannot go out in space and create a star, but we can build a model to represent our ideas of how a star is created.

Science Activity/Experiment

Activity Title: Jam Jar Clumping Experiment

Purpose of Activity: To show how a young star can be formed from the gravitational collapse of matter in a stellar nebula.

Activity Instructions:

- Give each student or a pair of students 1 jar with the lid with some flour inside (the exact amount depends on the size of the jar you are using – try it before the lesson to decide the how much flour).
- Go around and give them a bit of water – it's best to give them a little bit at a time, too much water will prevent the flour from clumping.
- Ask them to fit the lid and shake the jar until they have clumps – they might need more water.
- Discuss with the students
  - What does the flour represent? (gas and dust in the nebula)
  - What does the water represent? (gravity)
  - What does the shaking represent? (explosion)
- Explain to the students that the large clump in their jar is called a Protostar, which is the young star.
- Go through the lifecycle of a star explaining what happens after the Protostar stage. It helps to make a cycle diagram and fill in the blanks together to the star when it moves from one stage to the next – show labeled pictures or make drawings of the different stages – they will need a visual to make the flipbook.

Science Activity/Experiment

Activity Title: Role-play the lifecycle of a star

Purpose of Activity: Demonstrate the stages of the life of a star

1. Take the students to a large area, such as a gym, or if the weather allows, outside.
2. Students holding hands, will form 2 rings – an outer ring and an inner ring
3. Outer ring students should be facing outside and inner ring students should be facing inside
   - If you have two adults to coordinate the activity, it's best to have one person at the center of the inner ring
4. Explain that each student is now a particle of the star – the outer ring represents the outer core and the inner ring the inner core. Ask them about the characteristics of each layer

- o What is in the inner core? (gases)
- o What do the gases do? (bump to produce heat in a nuclear reaction)
- o What is the main force acting on the outer core? (gravity)

5. The inner ring is becoming hot – the teacher can start spinning around in the center pushing the students away from the center – so the inner ring is getting bigger – students move apart but still holding hands
6. At the same time the outer ring should be moving in – gravity is pulling them towards the inner core
7. This will happen until the students in the inner ring and the outer ring have their back touching, so no one can go any further out or in – the star is now in equilibrium
8. The teacher in the center will stop spinning to represent the near depletion of hydrogen gas – the star is now cooling down so the outer layer expands (outer ring gets as big as possible). This is the Red Giant stage
9. The inner ring should crouch to show the inner core collapse – the helium gas in the inner core is very close together which causes it to repulse each other.
10. The outer ring moves toward crouched inner ring - outer core collapses because of gravity.
11. Suddenly inner ring students get up and outer ring run away – this is the supernova explosion
12. Inner ring students stay facing out with their arm extended to grab anything that comes near – this is the black hole

Closure discussion:

To solidify the knowledge from the role-play, instruct students to make a flipbook or just a diagram of the lifecycle of a star. See pictures attached.

Nebula→Protostar→Star→Red Giant→Supernova→Black Hole/Neutron Star/White Dwarf

A cycle diagram helps the children connect that a supernova explosion, at the end of a star's life, will be part of the making of a new star. (this also connects the two activities well)

Scientific Report: ask them to write and illustrate with pictures of the lifecycle of a star on their space journal.

References

1. **http://school.discovery.com/lessonplans/programs/exploringstars/** . Discovery Education. DiscoverySchool.com. Lesson Plans Library. Accessed April 2007. [flipbook instruction and star lifecycle vocabulary – Exploring stars video is highly recommended]

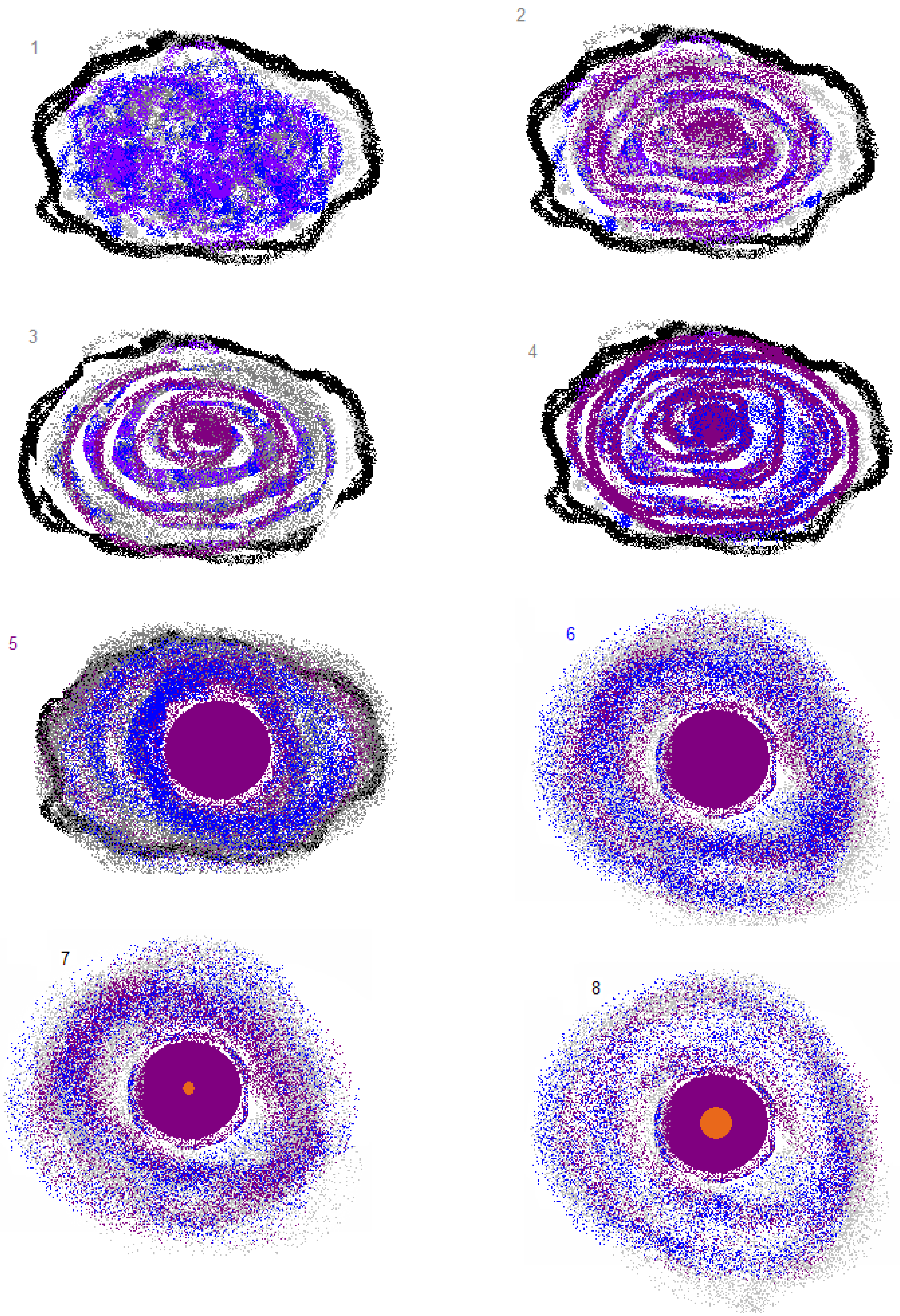
2. **http://btc.montana.edu/ceres/html/LifeCycle/stars1.html#activity1**. Star Life Cycles. NASA/MSU-Bozeman CERES Project. Accessed on April 2007. [instructions for extension activity]

Teacher Assessment of Learning

1. Do the students know the 'ingredients' to make a star?
2. Are the students able to recognize the names of the stages of a star's lifecycle?
3. Are the students able to correctly order the stages of a star's lifecycle?
4. Do the students understand how a star transitions from one stage to another?

Extension of Lesson Plan

1. This lesson could be preceded by an investigation of what makes a lifecycle. The NASA website proposes an activity where students investigate what makes a human lifecycle. Students are given a series of pictures of people ranging in age from 1 month to 90 years, and are asked to place it in order and give a detailed explanation as to why they placed it in that order. This activity helps them understand how scientists might go about figuring out the order of the star's lifecycle (or any other lifecycle).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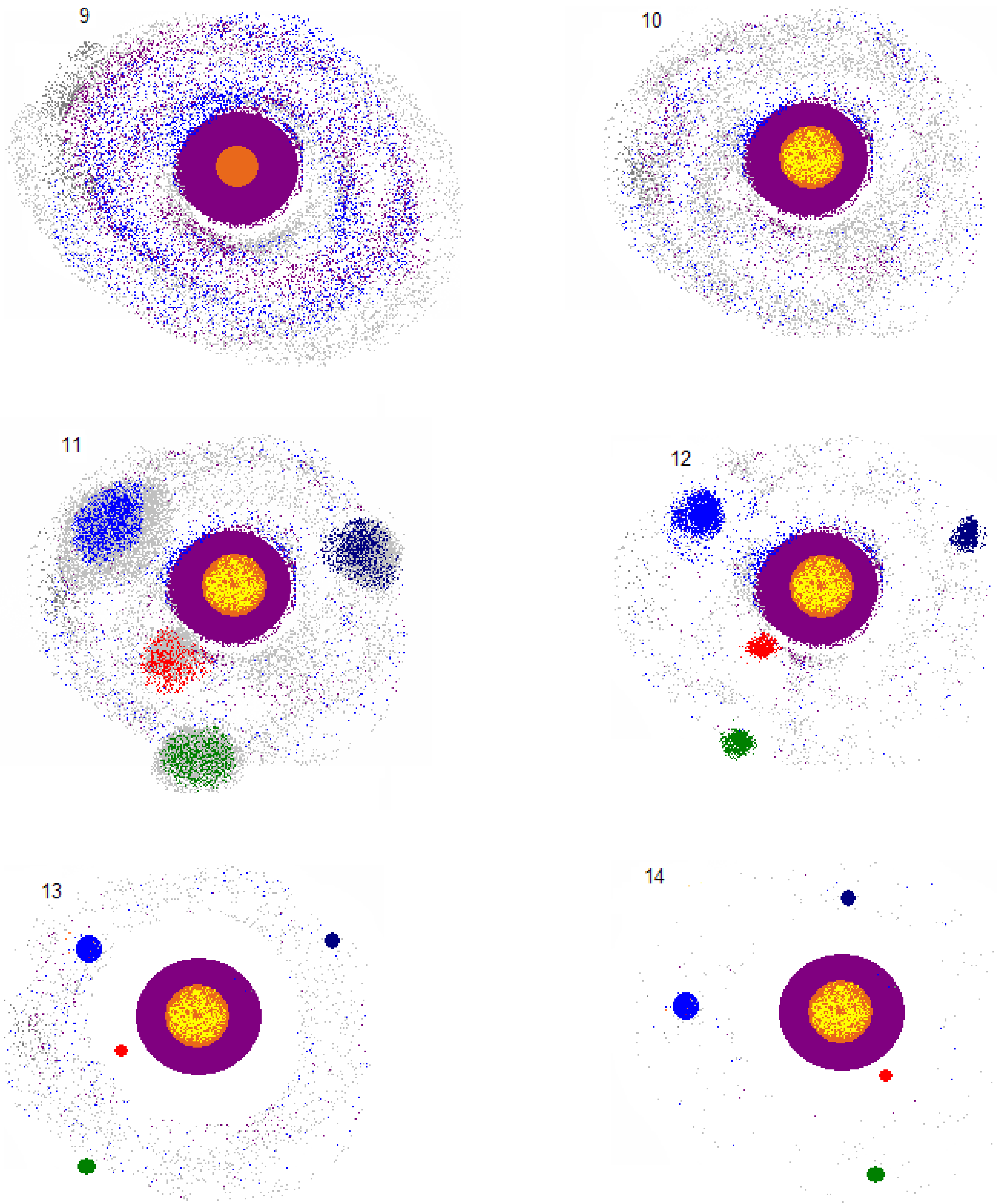
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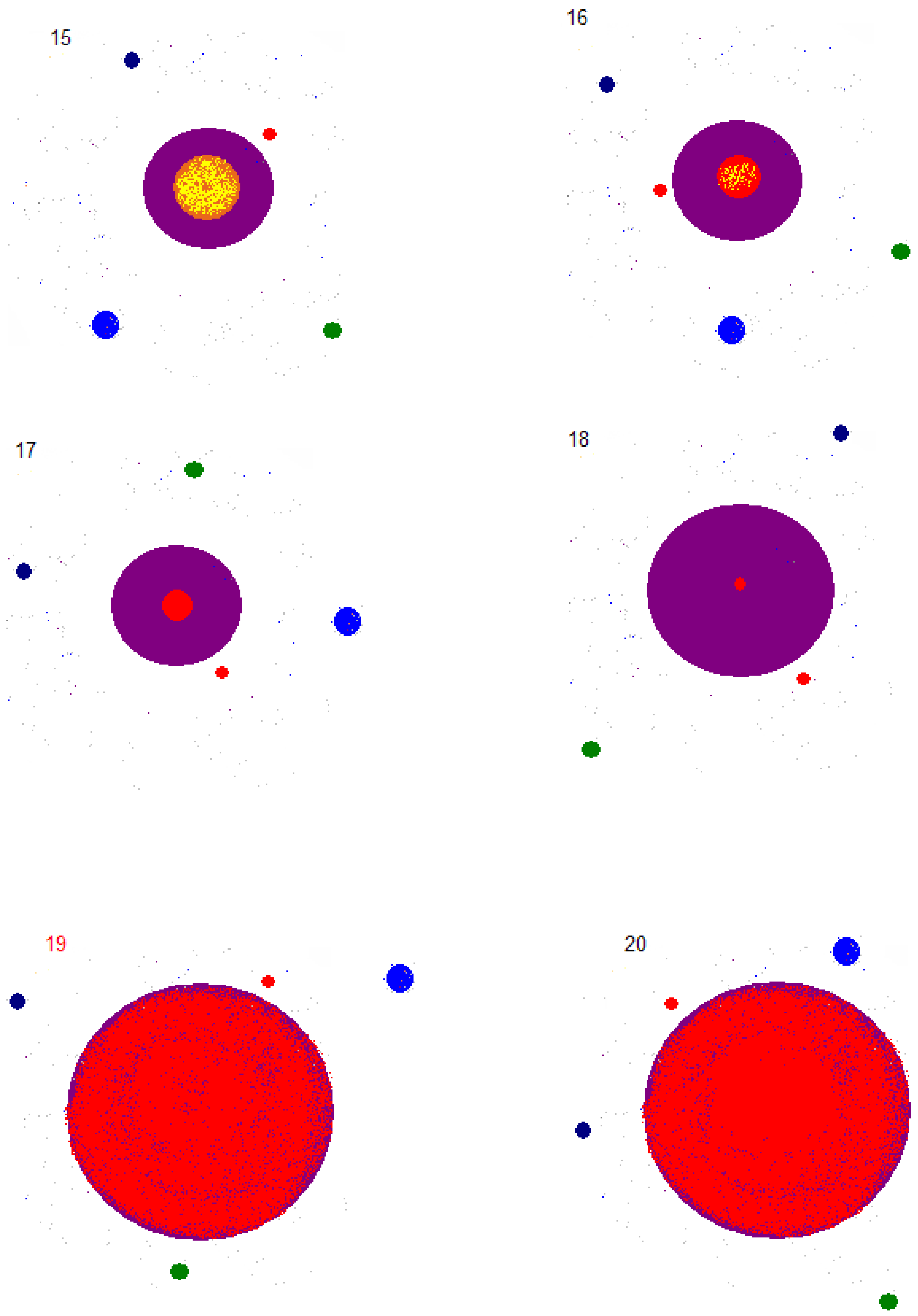
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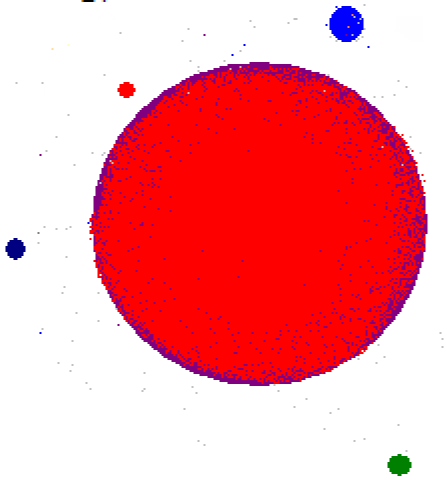

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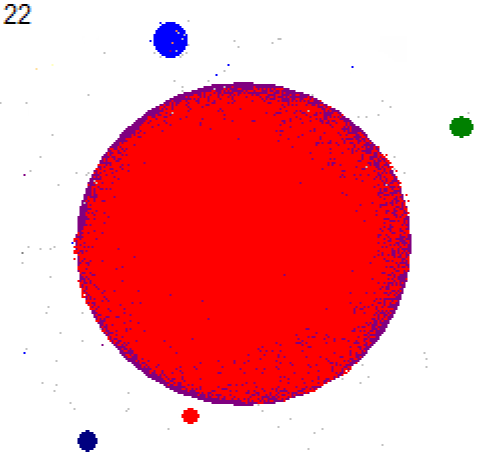

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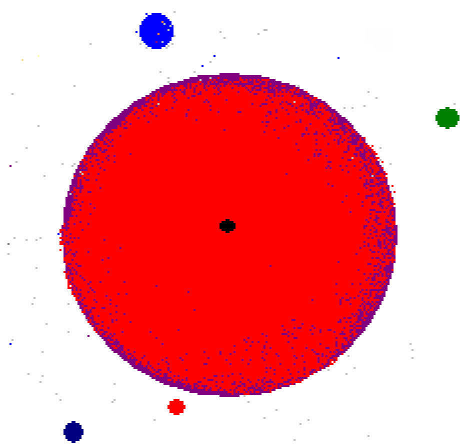

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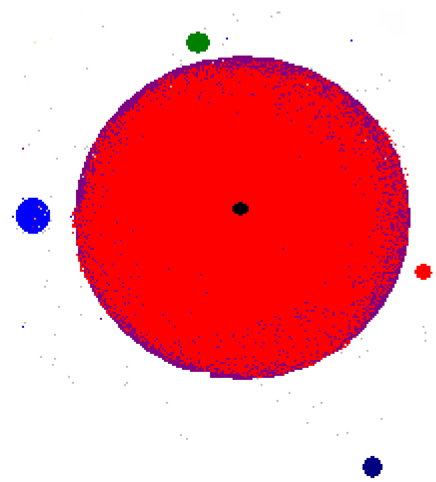

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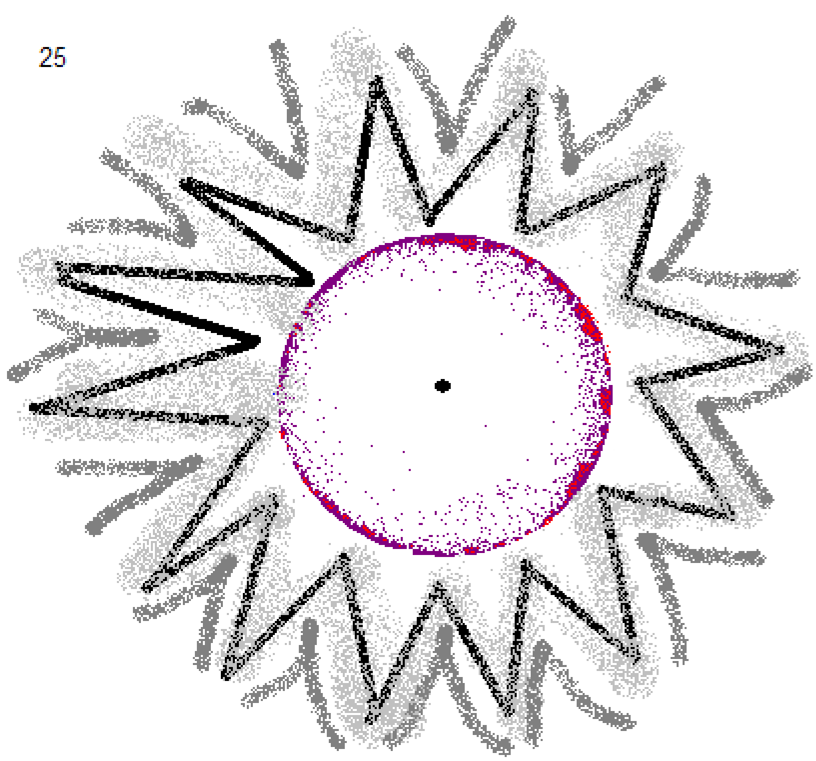

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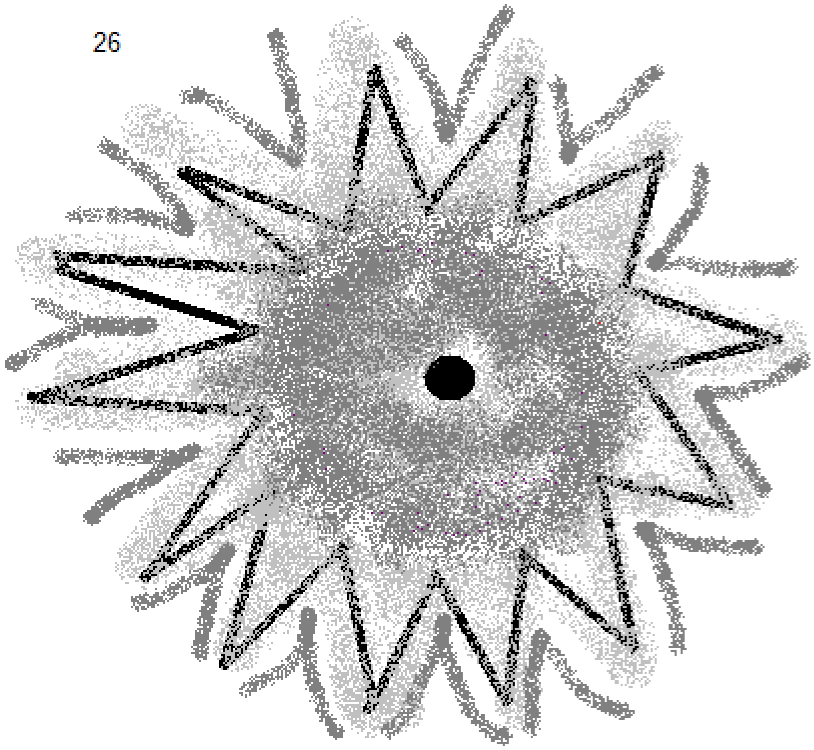

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