Asteroid Hunters

What's this activity about?

Big Questions:

- How are asteroids discovered?
- How fast do asteroids appear to move in the sky?
- How are infrared detectors used to locate more asteroids?
- How does the WISE Mission detect asteroids?

Big Activities:

Find asteroids in a starfield and discover why astronomers are locating even more asteroids using infrared detectors.

Participants:

From the club: One or two presenters can lead this activity.

Visitors: Appropriate for families, the general public, and school groups ages 10 and up. Up to 3 visitors at a time may comfortably share a set of starfields. For larger groups, there are 4 copies of each starfield included.

Duration:

10-15 minutes

Topics Covered:

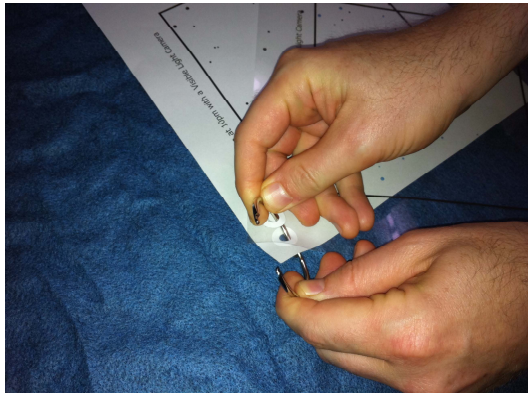
- How scientists search for asteroids in starfields
- How an infrared camera sees temperature

Where could I use this activity?

ACTIVITY	Star Party	Pre-Star Party – Outdoors	Pre-Star Party – Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Mtg	Gen Public Presentation (Seated)	Gen Public Presentation (Interactive)
					K-4	5-8	9-12			
Asteroid Hunters		√	√	√		√	√	√	√	√

What do I need to do before I use this activity?

What materials from the ToolKit are needed for this activity?	What do I need to supply to run this activity that is not included in the kit?	Preparation and Set Up

• 2 sets of starfields -- one taken in visible light and one in infrared
• Pictures of warm rocks in visible and infrared
• Clay, a ruler, and cratering implements to make models of the asteroids:
  ○ Ceres, 7.3cm, black
  ○ Pallas, 4.1cm, black
  ○ Vesta, 4.1 cm, light gray
	
	For large groups, use all four copies of the starfields.
		• Make models of the asteroids at least 3 days prior to activity. See "Making Model Asteroids" at the end of this activity
		• Punch holes in the top left corner of the starfields and attach them with binder rings. Each transparency should be placed on top of a corresponding card. Make sure to keep the Visible and Infrared sets separate.

Background Information

NASA's Wide-field Infrared Survey Explorer (WISE) is an unmanned satellite carrying an infrared-sensitive telescope that will image the entire sky. Among the objects WISE will study are asteroids, the coolest and dimmest stars, and the most luminous galaxies.

Take a look at the NASA WISE Mission PowerPoints on the Manual & Resources CD. These will give an excellent overview of the mission and the science. They can also be found online here:
http://wise.ssl.berkeley.edu/gallery_slideshows.html
Also, the website is full of information and images:
http://wise.ssl.berkeley.edu/mission.html

Difference between Heat and Temperature (excerpt from Cool Cosmos)

When talking about warm asteroids, it's good to be reminded of the fundamental difference between heat and temperature. In casual conversation, we often refer to heat and temperature interchangeably. However, to be precise, heat and temperature are different concepts, related to each other.

Heat is the total energy of molecular motion in a substance while temperature is a measure of the average energy of molecular motion in a substance.

For example, the temperature of a small cup of water might be the same as the temperature of a large tub of water, but the tub of water has more heat because it has more water and thus more total thermal energy. Temperature does not depend on the size or type of object.

It is heat that will increase or decrease the temperature. If we add heat, the temperature will become higher. If we remove heat the temperature will become lower. Higher temperatures mean that the molecules are moving, vibrating and rotating with more energy.

Heat is energy; temperature is a measure of it.
http://coolcosmos.ipac.caltech.edu

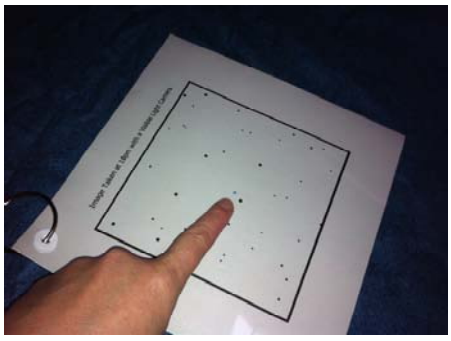
Additional Asteroid Belt materials from the Dawn Mission

On the Dawn website, you can find image galleries, activities, and much background information:
http://dawn.jpl.nasa.gov/

Detailed Activity Description

Asteroid Hunters

Leader's Role	**Participants' Role (Anticipated)**
To say: Is anyone concerned about asteroids hitting the Earth?	Yes!
Well, we are keeping our eyes out for potentially hazardous asteroids and nothing we've found so far is headed our way. But it is pretty much guaranteed that an asteroid will eventually hit Earth and we want to be prepared. Don't worry too much; the chance of that happening in our lifetimes is very small.	
Scientists are taking the first step towards being able to avoid an asteroid impact now. Can you guess what that is?	Blow it up! Shoot it!
Well, before we decide what to do about it, we have to find out if any of them are headed our way. Astronomers want to find the potentially hazardous asteroids with enough warning to do something about it. Do you want to see if you can spot an asteroid?	Sure.
Let me show you how it's done. When we look through our telescopes, and even with large space telescopes, most asteroids just look like any other point of light. They're too small and far away to see their shape. So essentially they look just like dots, just like stars except for an important difference. Can anyone guess what that is?	They shoot across the sky!
Well, you're close -- they do move. They don't shoot across the sky like a meteor. They are moving fast but they are far away so it looks slow to us. But over an hour or so, you can see a difference.	
Misconception Tip: The sizes of dots in the starfields do not represent the *size* of the object, but its *brightness*.	

Leader's Role	**Participants' Role (Anticipated)**
<u>To say:</u> Here's one way we find asteroids. An astronomer takes a picture of one piece of the sky. It looks something like this. Can you tell which of these dots is an asteroid?	No
<u>To do:</u> Hold up one visible light card.	
<u>To say:</u> Then she waits, and an hour later takes another picture. It looks a lot like the first.	
<u>To do:</u> Hold up the visible light transparency.	
<u>To say:</u> Astronomers simply line up the dots and see if any of the points moved over that hour. We've made the second image a different color so it's easier to see. If any dot has moved compared to the rest of the field, you know that point of light isn't a star. Would anyone like to try to find the asteroid in these pictures?	Sure!
<u>To do:</u> Pass out Visible starfields to the group. Up to 3 people can comfortably use a starfield. 	*Finding the asteroid (in the center)*
<u>To say:</u> Great! That's exactly how scientists have been finding asteroids for over 100 years. But recently we've been able to use even better tools. Can anyone guess what those are?	Computers

Leader's Role	**Participants' Role (Anticipated)**
To say: Absolutely! Using computers means that humans don't have to look over and over at countless frames like this. But asteroids are still hard to find. That's because they are small and very dark. Most of them are blacker even than asphalt, like this model. *To do:* Hold up small dark asteroid model. *To say:* But because asteroids are so dark in color, they are hard to see. *To do:* Find someone wearing black or a black car. Ask them to be your "background". Make a circle with your hand and hold it to your eye to simulate a telescope, as in the picture on the right. *To say:* Everybody else get out your telescopes. Which one of these asteroids would appear brighter to you on Earth? Remember, all we see is a point of light. *To do:* Hold the two small asteroids in front of the dark background. *To say:* Right, to our eyes, the one that reflects more sunlight appears brighter. The lighter gray appears brighter. In fact, in a telescope you might even be able to see this small bright one better than a large asteroid that's very dark. *To do:* Hold up the large dark asteroid next to the small light one.	The light gray one is brighter than the black one.

Leader's Role	**Participants' Role (Anticipated)**
<u>To say:</u> Remember, they just look like points against the black of space. We see the sunlight they reflect, but can't tell their shapes or how big they are. So we have come up with a different way of looking. I'll tell you how it works. Have you ever been out in the sun in a dark t-shirt?	Yes
What happens?	It gets hot
Right. The same thing happens to asteroids! They get warm. Hmmm… So if we could just measure the <u>temperature</u> of the asteroids, we could see them a lot better. And that's exactly what scientists do. *(See Background Information for more on the difference between heat and temperature.)* There are special cameras called infrared detectors that basically "see" the temperatures of objects. Here, take a look at this picture. *<u>To do:</u>* Hand one card with warm rocks to an audience member and hold the other for the rest to see. Start on the visible light side. (looks like one white rock) *<u>To say:</u>* This is a picture of two warm rocks on a cool black background. Really, there are two rocks there. One is hard to see, isn't it?	Yes
Well, on the other side is a picture of those same rocks taken with an infrared camera. An infrared camera detects temperature. Look at how bright the large one is compared to the background! But, is this what the rock looks like to our eyes? No, this picture of the rock taken with an infrared detector shows how warm the rock is. We do the same thing with asteroids.	No

Leader's Role	**Participants' Role (Anticipated)**
Misconception Tip: While asteroids are warmer than the surrounding space, they are still very cold in comparison to temperatures on Earth. The average surface temperature of a typical asteroid is -100 degrees F (-73 degrees C). The surrounding space is much, much colder.	
To do: Hold up the infrared card next to the visible light card. *To say:* Does anyone want to see that same starfield taken with an infrared camera? Compared to the cold, cold background of space, both asteroids and stars shine brightly in the infrared. Can you see more dots? Can you tell which are stars and which are asteroids? What should we do? Right, here you go. This picture was taken an hour later. Go ahead and see if you can line up the dots. *To do:* Flip the transparency over and hand out the two infrared starfields to visitors. *To say:* That's because so many of the dots you see here are actually asteroids! Wow! Look at all the asteroids that infrared detectors can find. NASA's WISE Mission took pictures of the sky with infrared cameras every hour. Do you think that might be a good way to find asteroids? Absolutely. It found hundreds of thousands of asteroids in less than a year. That gives us a better idea of the asteroids in the Asteroid Belt. And it can warn us of any potentially hazardous asteroids that might be coming close to us too. This is the first step in eventually protecting Earth from dangerous asteroids.	Yes No Take another picture! It's hard to find Yes

Common questions:

Can we see infrared from ground-based telescopes?
Some parts of the near infrared spectrum make it through the atmosphere. And a few windows of longer wavelengths make it to the ground as well. But the atmospheric greenhouse gases, especially water vapor, absorb most infrared. So WISE orbited Earth taking pictures out in space where it's cold and clear.

Are dark asteroids brighter in infrared?
Yes, and the difference between what we can see in the infrared and what we see in visible light tells us about the surface of the asteroid.

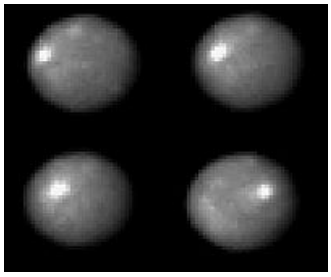
Misconception Tip:
There are many wavelengths of infrared. Only the longest can be detected as temperature. Near infrared is used in remote controls and wireless hardware, and we do not detect this as temperature with our skin.

What do I need to prepare?

Asteroid models:

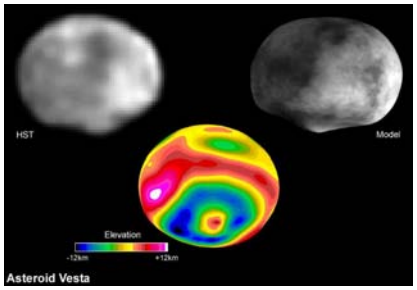
To make clay scale models of the three largest asteroids in our Solar System, here are some guidelines and examples, scaled to a 1-meter Earth. (Note that these are simply approximations of their appearance because the asteroids have not been seen in fine detail.) Use air-dry clay and non-toxic black and gray paint. Use pens and beads to make craters all over the surface:

Ceres is the largest asteroid and also a dwarf planet. It is spherical and likely very cratered. On this scale, it is 7.3 cm (3 in) in diameter and blacker than asphalt.



Top two images: Hubble

Vesta (middle) and Pallas (lower) are the next largest. They are similar in size but with different shapes and colors. Vesta looks like a sphere with an enormous crater smashed out of one side (flattened). Vesta is a light gray color and 4.1 cm (1.6 in) across. Pallas probably looks more like a lemon with dents and is the same black as Ceres. It is 4.1 cm on its long side like Vesta.



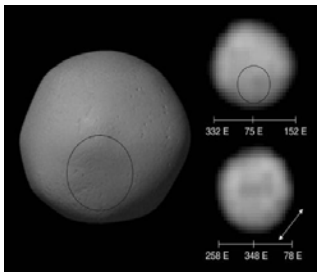


Image: Science / AAAS

Where do I get additional materials?

1. Air-dry clay can be found at art stores or toy stores. If you can't find black clay, you can paint dried models with non-toxic paints.
2. **Transparency sheets** can be found at office supply stores or copy centers. Be sure to get the type that works with your printer.

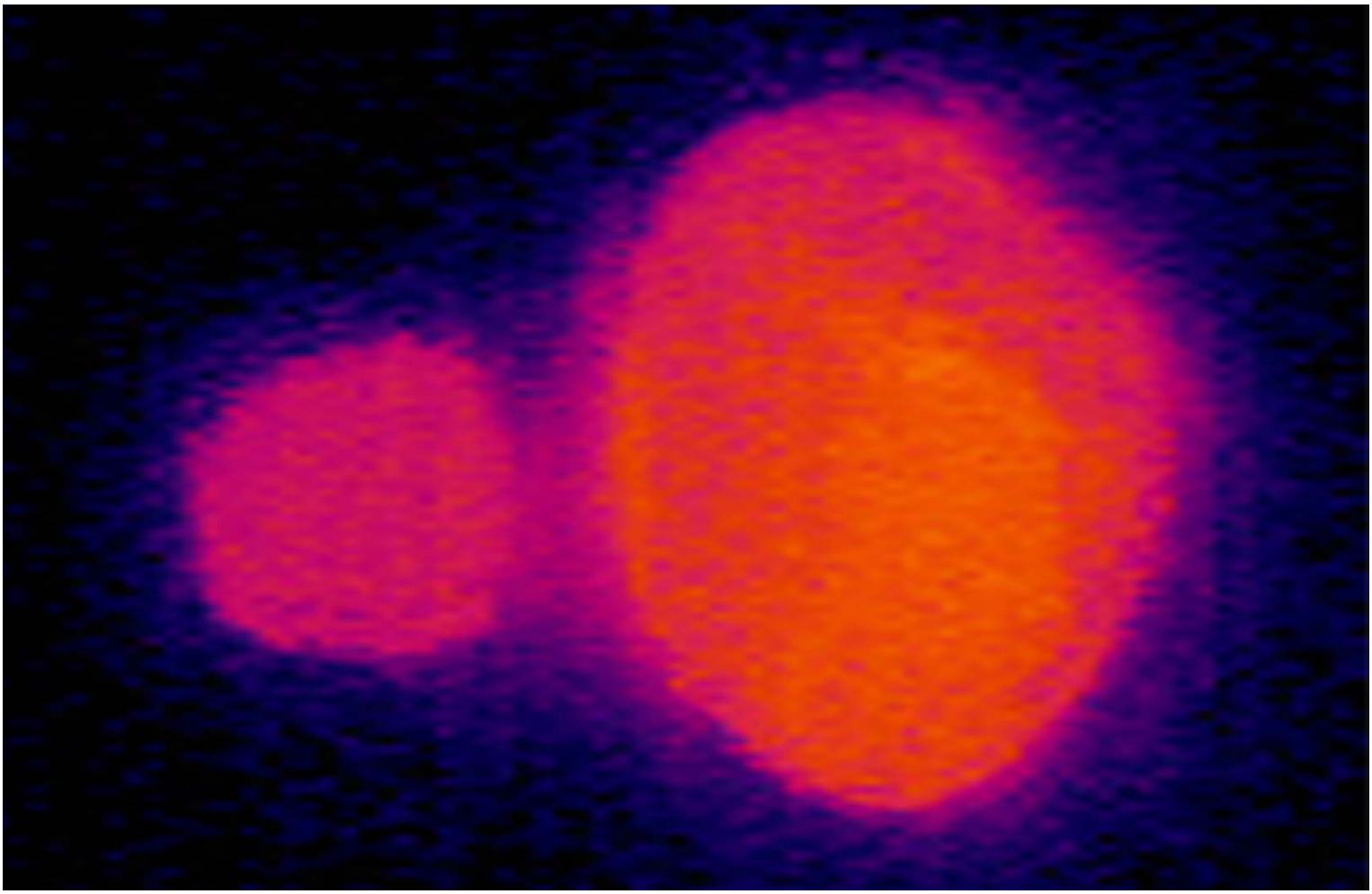


Image Taken at 10pm with a Visible Light Camera

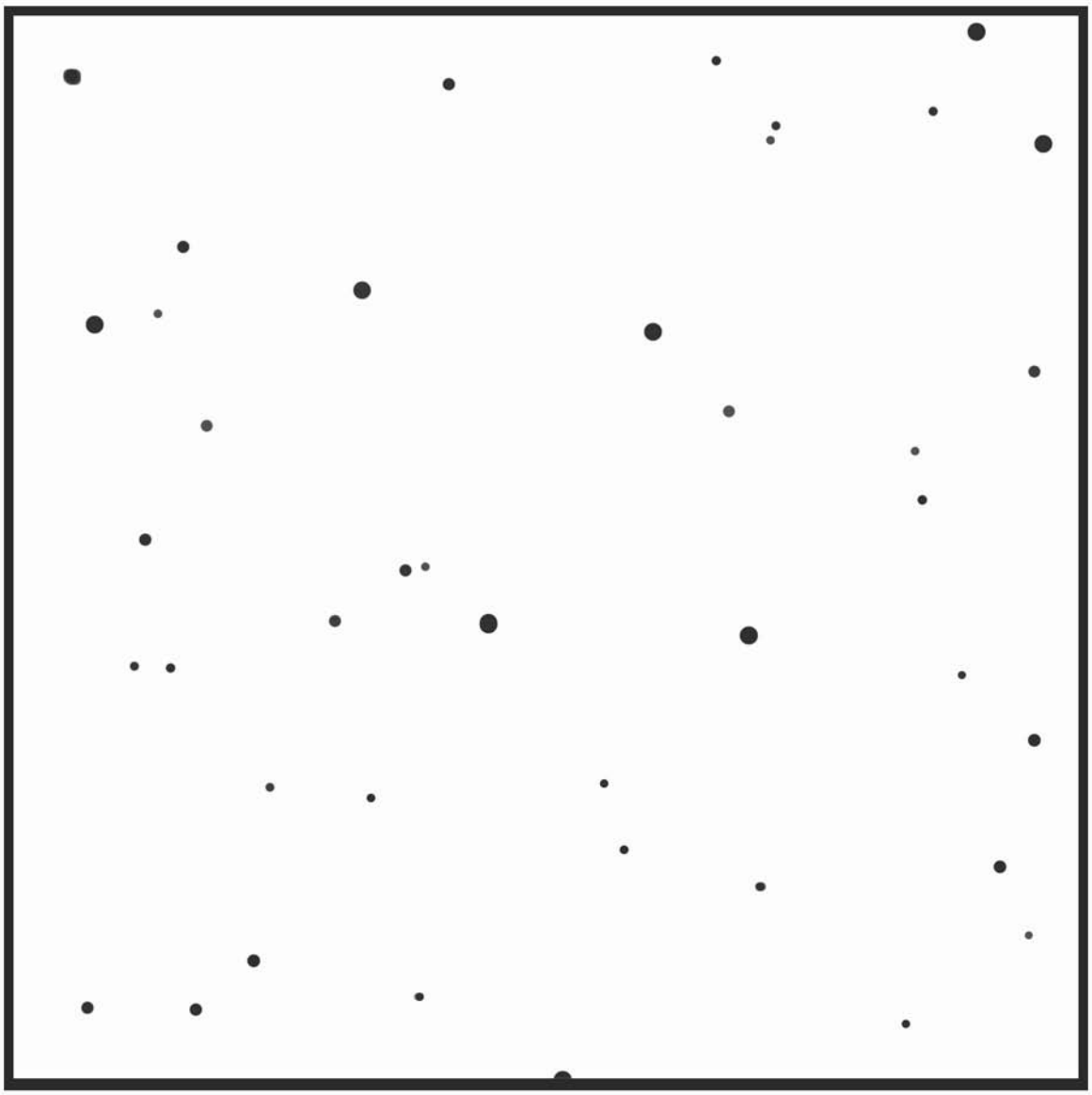


Image Taken at 10pm with an Infrared Camera

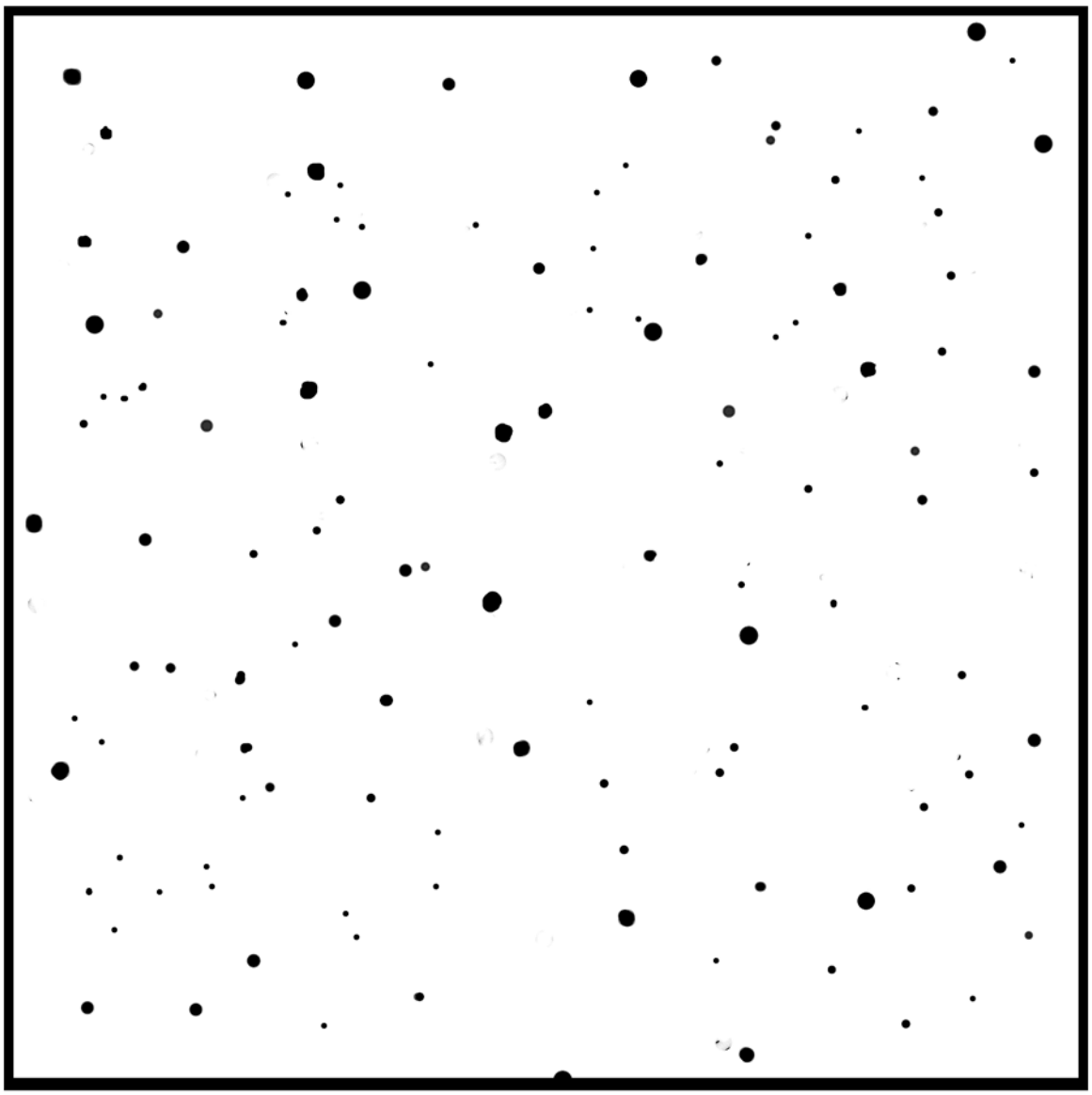


Image Taken at 11pm with a Visible Light Camera

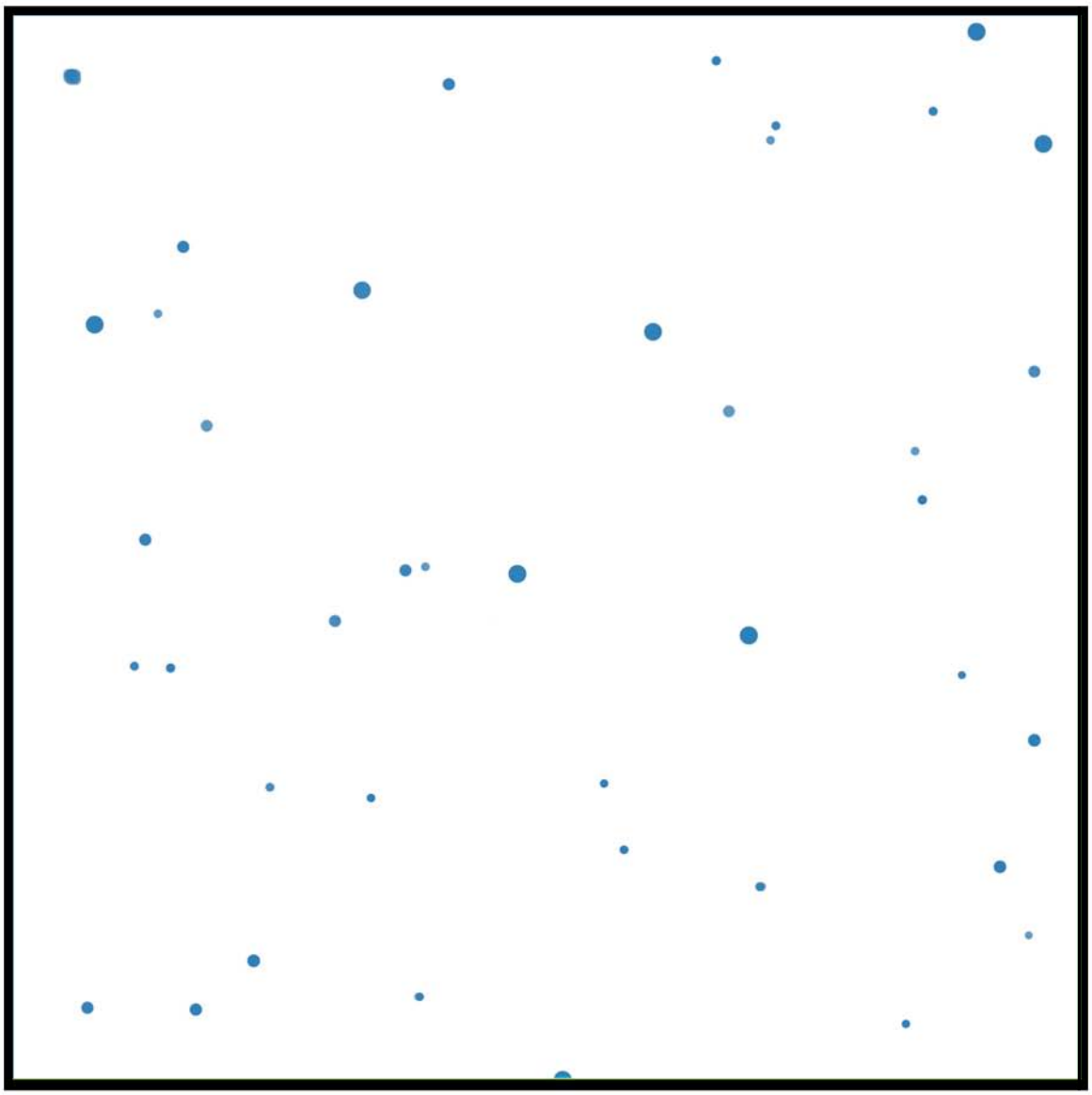


Image Taken at 11pm with an Infrared Camera