

## MITOCW | Investigation 2, Part 4

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**PROFESSOR:** And we've so far gotten to the point where we can calculate. So this is-- we can calculate the amount of energy. Remember now, we've moved beyond counts per second into energy per second.

The amount of energy collected per second now is equal to-- we've still got the area of our collector. Divided by this  $4\pi$  the distance from object to collector squared times-- and now we've got the we're going to call this the luminosity, and we said the luminosity is amount of energy emitted per second. Let's put this in parentheses.

That's what this is. So what we can do now, if we wanted to-- we've got our measurement in energy per second. I could give you the area of the collector, which is just the area of the opening hole in the telescope. If I gave you the distance to this object, which I measured, I would be able to predict, from this measurement plugging in these values here, I would be able to predict what the luminosity of that bulb is. And that's what we're going to do.

Luminosity is this measurement that we've been trying to get to. We wanted to turn a measurement of an image into a measurement of the total amount of light emitted by a source. So there it is luminosity is the amount of energy emitted per second from the source. Unfortunately, astronomers don't always do things in a nice, easy way that makes sense to the rest of us right away.

So what they do, they don't measure the amount of energy collected per second. That is a measurement, but we want to, if we took the area of the collector, because look. This depends on our image and our collector and our detector. This, the area of the collector, also depends on the collector part of our system. The distance from the object to the collector, that kind of depends on the object.

You know, if it's farther away, this number is going to be bigger. So the light will spread out further. And the luminosity is obviously a property of the object way out there in space. So what we want to do is we want to say, let's put everything on this side that has to do with the object, and put everything on this side that has to do with our collector and our detector.

So what astronomers do is they divide both sides by the area of the collector. Now in this case, we can cancel out the area of the collector. We've just divided both sides of an equation by a number. And what we have over here, this is a new measurement. And astronomers call this flux equals, now we've got  $1$  over  $4\pi$  times the distance from object squared times the luminosity.

And the flux is just the amount of energy collected per second divided by the area of the collector. So in the same way that before we were talking about normalizing to the amount of time that you have your camera open, which meant that we divided by the amount of time that was in our exposure. Now, we're normalizing to the area of our collector. So we just divide by how many square meters, or how many square centimeters are there in our detector.

So this relationship, again, whenever we have-- so this is important. This is going to be our relationship between what do we measure here on earth. So flux is what we measure or what we observe. Flux is what we observe. Luminosity and distance are properties of the object. OK?

So over here on this side, we've got properties of the object. On this side, we've got this is what we observe. So let's just do a little bit of algebra together. Let me erase this. So right now, we have a relationship between something that we can observe, and something that we want to find out. We want to find out the luminosity of this object. OK?

So if I wanted to solve this equation for this number right here-- to do a little bit of changeeroo here, I'm going to replace each of these words with a letter just so that we can see it a little bit easier. And I'm just going to rewrite up here, we're going to say flux,  $f$ , is equal to 1 divided by 4 pi d squared times  $I$ . OK? I can rewrite that as just  $f$  equals 1 times  $I$  is  $I$  over 4 pi d squared.

If I'm measuring flux and I want to find luminosity, I want you, as a group, to solve this equation. Solve the equation for  $I$ , which means I want  $I$  to be alone on one side of the equation, and I want everything else to be on the other side. OK?