MITOCW | Investigation 6, Part 6

MARK HARTMAN: So let's hear it. What was the most important difference between these two types of galaxies? Let's see, Bianca, Steve, and [? Nicki. ?] You raised your hand?

AUDIENCE: [INAUDIBLE].

MARK HARTMAN: All right, let's start with Bianca and Steve, and somebody else has to be brave.

AUDIENCE: So in the false color [INAUDIBLE] light image, you can actually-- in the spiral galaxy, you can actually see the form of the spiral galaxy, see the arms, how it looks. But in the X-ray [INAUDIBLE] image, you only see a scattering of stars, so you can't really actually see the form of the galaxy. And in the elliptical galaxy, you can see the [INAUDIBLE] galaxy in the false color [INAUDIBLE] light. And in an X-ray image, you can also see the center, so you know where it is you're [INAUDIBLE].

MARK HARTMAN: All right. Steve, what do you think?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: What about it?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: So angular size is a big difference. How about somebody else from this group, group number three? Anybody want to volunteer? [INAUDIBLE] What's the thing that you wrote down?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: So everybody listen up over here.

AUDIENCE: [INAUDIBLE] galaxy [INAUDIBLE] actually see the arms of the galaxy [INAUDIBLE] But when you [INAUDIBLE] you can see all the [INAUDIBLE]

MARK HARTMAN: In which one? In spiral galaxies or elliptical galaxies?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: Right, you can't see individual stars in [INAUDIBLE] OK? So here's a question for you, and I think you actually swapped around [INAUDIBLE] But we've got-- they're very different. Elliptical galaxies show a smudge in both visible light and in X-ray light, but they're not the same shape in visible light and X-ray light, at least this galaxy. It's not a nice smooth X-ray image.

Whereas over here, you've got this nice spiral galaxy, but do you see that spiral pattern when you look at it in X-ray light? No. You just see these individual little dots. And Bianca was saying, well, you can't see the spiral pattern. For these people on this side, are the dots in the spiral arms or not?

AUDIENCE: Yeah.

AUDIENCE: Some.

MARK HARTMAN: Some of them? Are they all in?

AUDIENCE: No.

AUDIENCE: Some of [INAUDIBLE]

MARK HARTMAN: Some are in the gaps in between, the places where there's low flux in the visible light. OK, so you guys have done a lot of observations. You learned a little bit about things that give off X-rays. What's going on? What's our model for why are these different?

[RING]

You guys want to grab that?

AUDIENCE: The arm itself--

[RING]

MARK HARTMAN: The arm itself gives off X-ray light.

AUDIENCE: The arm [INAUDIBLE]

MARK HARTMAN: OK, does it?

AUDIENCE: [INAUDIBLE] could be because it's not a hot enough temperature.

MARK HARTMAN: OK, so the gas is not hot enough to give off X-rays. So we're not seeing the spiral arm. We're only seeing the dots in the spiral arm and they're not even all in the spiral arm.

[RING]

AUDIENCE: Gosh!

MARK HARTMAN: Check again. And if it's still the same, say please don't call back.

[RING]

AUDIENCE: They asked for Joanna last time. Hello?

AUDIENCE: That the spiral arms are made up of more visible-- of more objects that give off visible light than objects that give off x-rays.

MARK HARTMAN: OK, so the spiral arms are made of objects that give off lots of visible light and not made of a lot-- in the spiral arms, there's lots of objects that give off visible light but only a few objects that give off x-ray light. What do you think those objects that give off visible light are?

AUDIENCE: Stars.

MARK HARTMAN: Stars. What do you think are the objects that are giving off x-ray light?

AUDIENCE: Super stars?

MARK HARTMAN: Super stars! What do we call super stars?

AUDIENCE: Galaxies?

MARK HARTMAN: No, this is only one galaxy. What could those be?

AUDIENCE: Neutron stars?

MARK HARTMAN: What kind of neutron stars?

AUDIENCE: Binary systems.

MARK HARTMAN: Those are x-ray binary systems in another galaxy because they're tiny little dots. They're point sources Why can't we see individual stars in the visible light image but we seem to be able to see those dots in the x-ray light image? OK, I want you to think about that because I'm going to ask you to write about that in just a minute, OK? Thinking back to a bunch of other things, what is it that is giving off X-ray light? If over here, the only thing that we're seeing are these little dots which we think are super stars or X-ray emitting stars-- neutron stars, X-ray binaries, black hole binaries. You know, X-ray binaries include black hole binaries as well.

AUDIENCE: [INAUDIBLE] all stars?

MARK HARTMAN: Possibly, but a good thing check there is how luminous would you expect a B or an O star to be? You can actually calculate the flux there. We can give you the distance and you can find out how luminous are these objects? I don't think you can find that they're as luminous-- or an O star is not luminous enough in x-rays to be able to show up. But one of these X-ray binaries might be.

So let's got back to the other side of the room. If we have a model for what we think these dots are in the spiral galaxy, what few things giving off x-ray light in the elliptical galaxy? Stars don't give off X-ray light? What do you think, David?

DAVID: The nucleus?

MARK HARTMAN: The nucleus? What is the nucleus?

DAVID: The central region.

MARK HARTMAN: The central region. Why would the central region maybe give off X-ray light?

DAVID: Maybe there's a black hole there.

MARK HARTMAN: OK, maybe that's why there's that bright or that high flux spot in the middle whereas here was there a high flux spot in the middle in this one? I honestly don't know.

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: In the visible light? In X-rays?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: No. So what does that tell us about this galaxy? There's no nucleus?

AUDIENCE: It's weird.

MARK HARTMAN: It's a weird galaxy?

AUDIENCE: It's a joke [INAUDIBLE]

AUDIENCE: There's not a black hole?

MARK HARTMAN: If you're going to something, say it to all of us.

AUDIENCE: What does it even mean?

MARK HARTMAN: So David says, in the x-ray image, this is the bright in the center because a model could be maybe there's a supermassive black hole there. But if there's no bright spot at center in the spiral galaxy in X-rays, what does that mean? Lauren?

LAUREN: There's probably no supermassive black hole there.

MARK HARTMAN: There's probably no supermassive black hole there. We could say, oh yeah, it's there. But maybe there's a cloud covering it up. Could be, we'd need to do some other observations. And if you looked at it for a long time, we'd see it wink back. So what did David tell us us about this morning that also gives off X-rays? Chris?

CHRIS: The hot gas.

MARK HARTMAN: OK, so maybe the x-ray stuff over here is not x-ray binaries. But does it look like points? Like the x-ray stuff over here, does that look like points? How did you describe it? Let's have a word from the people over here. We're talking about the texture or the shape. How did you guys describe your x-ray image of this galaxy? I can't hear a word that you're saying. That doesn't mean that you should be quiet. That means you should be louder.

AUDIENCE: That you see all these [INAUDIBLE]

MARK HARTMAN: OK. Lauren?

LAUREN: In the center of where the galaxy is supposed to be, you'll see that there's a lot of light there and then there's the shape around it that's not [INAUDIBLE]. So that could be [INAUDIBLE]

MARK HARTMAN: OK, but the important point is it's not dots. It's not a compact dot. It's not a point source object. It's an extended source. I think David described one that I think we say up there as extended. Right? Steve also had an interesting question about how can I tell something is a galaxy or if something is a star? And what did we decide?

AUDIENCE: [INAUDIBLE] they're stars. When they're [INAUDIBLE] they're galaxies.

MARK HARTMAN: OK, what was the other thing that we use to describe galaxies?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: OK, galaxies are fluffier. They're oval shaped. If you have something that's round, it could be a galaxy or it could be a star. But bright stars normally have little spikes on them. And you guys will see on the right hand side, you'll see a bright object, but it has spikes on it. That actually comes from when light from a point source gets changed by the telescope just a little bit. OK? Those spikes actually have to do with the way that the mirrors are set up. So--