MARK HARTMAN: --of, let's say, detector and interstellar dust. Oops. Let's draw a line in between there. Response. And let me put myself back up there. Is that going to work? Can you guys put board one up?

Again, we have-- here's our source. It's putting out photons. In this case, we're talking about X-ray photons. X-ray photons are going out in all directions. We also have interstellar material. Some of these photons go through. Some of the photons go here and stop. Maybe the photon makes it a little bit further into the cloud, but still stops.

What we're interested in is, what is this-- we really want to know, what does the spectrum look like just after it's been put out of the source? Because that's going to tell us what's really going on at the source. But there's our source. There's our interstellar dust.

And then over here, we have Chandra, our detector. And some of the photons continue to go through. Some of the photons here are not collected by the detector. Some of the photons are. So this is our detector. That diagram should look somewhat familiar. I want you to leave a little space below it.

AUDIENCE: Mark.

MARK HARTMAN: Yeah?

AUDIENCE: Why is there one circle particle there?

MARK HARTMAN: Oh, because I didn't change it. Let's just all talk about x-rays for right now. So the detector puts out intensity versus energy. This is your actual observation. So this is your observation, and it looks like this. Or at least in the case of the neutron star, it kind of looked like that. This is what we observe-- our observation.

The computer has a model for what's going on at the source. It also has a model for what's going on in the dust. And can we switch, Shekib, to the other image? This is our model of what's going on in the dust. This model also has a parameter that the computer tries to change. It tries to change the amount of dust between us and the object.

Remember, we said that these high values were for very thin clouds, if there's not a whole lot of particles between us and the source. This one is for an average number of particles, and we see that we get much fewer low-energy particles. And this line is a prediction from the model, because you guys are actually fitting-- you're fitting a power law model and a dust model at the same time. Since there's always dust in the way, that model is always tacked on to whatever you guys fit. So you'll see if we have more dust, well, there's even fewer red photons that get through. So the computer has a model for what the dust does.

We have a model of the source, and we're going to say that was our black-body, or-- so we're going to have the model, black-body or power law, that we looked at there. Our dust also has an absorption model. And that tells us how much light and what energies of light are absorbed by that interstellar dust.

And we also have a model over here for the detector response. So the computer is actually taking, well, let's look at this actual model of the object that we want. I'll also throw in this model of the interstellar dust in between, and I also need to know how my detector responds, because I'm not going to collect everything. That's why we have the computer twiddle all the knobs, so that it can get a model that's close to what you observe.

This morning, when we were just looking at very simple models with visible light, we were able to change the parameters, and it made sense. We could do it pretty easily. Well, in this case, you've got to have several different parameters. So from this model, the black-body or power law, what do we predict?

For the black-body or power law, we predict the temperature. We could also predict the power law index. From the absorption model, we can predict-- and you'll see this. I know some of you guys had clicked on the Show Sherpa Fitting Logs. If you click on that option when you do the fit, you get a little bit more information. And there's a parameter called N sub h. You say that N sub h. That's how you say it.

AUDIENCE: What's that?

MARK HARTMAN: It's the letter N with a little h down below it. And what that is is-- we're going to call this column density. It's essentially related to the number of particles that are in the dust cloud between you and that object. So column density is related to-- let's say related to amount of dust. Now some of you, for your projects, will learn a little bit more about column density, but not everybody has to. So we're going to leave that out for now. OK?

And from the detector, we don't need to predict anything about the detector, because we're always using the same instrument. We're always using Chandra. But we need to know what the detector response is. So what the computer does is, it puts this model and this model and this model all together, and it allows us to fit-- maybe it doesn't fit perfectly, but it allows us to fit our observation, because we only observe the light that came through the cloud. We only observe the light that got detected by Chandra. So we need to know all this other stuff in between.

However, if we want to measure real stuff, we-- don't it's not that great to have just what we measure there. We actually want to know what is the light that was given out by the source. So that's why you have two separate lines that give you the flux in your output for your model. This temperature and power law index is for the source. This N sub h, or column density, is for the dust.

But what we're interested in-- let me get another color here. So this light-- the flux from this, that is-- the flux is what gets to Chandra. That's right, Dean. After the cloud. So it's what gets there. It hasn't had a detector response just yet. But we took out the detector response. That's probably kind of hard to read down there. And this is the flux on the first two lines. This is important. The flux on the first two lines is the flux that is getting to Chandra.

AUDIENCE: After what did it say?

MARK HARTMAN: After the cloud, because it's the light that came out after the cloud, or after the dust. But if we are fitting our model correctly, the flux from the second two lines is what was emitted by the source. And this is this flux over here. It's out of the source, but it hadn't yet gone through the dust. Because if we know what model we're using for this source and we know-- and we measure or we predict how much dust is in the way, well, we know how this works, so then we can work backwards and figure out, well, what's the flux that was actually put out by the source? That's interesting. That's what we really want to know.

So the second two lines is a prediction-- again, all of these things down here are predictions. That's the prediction of the flux emitted by the source. The flux on the second two lines. That's the flux emitted by the source before it went through the cloud. It's not what gets to Chandra after the cloud. Oops. I wrote emitted twice. Emitted by the source before the cloud. And in that case, we took out just the detector response. Here, we took out-- took out the detector and the cloud response.