Blueshift - "NuStar: NASA's Newest X-Ray Eyes"
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Sara Mitchell: Welcome to Blueshift, brought to you from NASA's Goddard Space Flight Center. I'm Sara Mitchell. One of the most exciting events in any astrophysicist's career is to be involved in the successful launch of a new satellite. This doesn't happen all too often, because it takes years to propose, develop, test, and launch a new spacecraft.

One of the highlights in 2012 for astrophysics has undoubtedly been the successful launch of the NuSTAR satellite, which launched in June and has given NASA a new set of X-ray eyes to look at some of the most powerful and energetic objects in the universe. To find out more about NuSTAR, we spoke with Dr. Dan Wik.

Dan Wik: I'm Dan Wik, I'm a post-doc here at the NASA Goddard Space Flight Center. I've been here two years now and have been involved heavily with the NuSTAR telescope.

Sara: So what is NuSTAR?

Dan: So NuSTAR stands for the, let's see, Nuclear Spectroscopic Telescope Array. But what it's doing is it's focusing high energy X-rays for the first time. And it does this by using a very unique design in the telescope whereby the telescope is really divided into two pieces: the mirrors, and then the instruments, and the spacecraft on the other side and they're separated by a boom that expands after the telescope is launched because you need a really large focal length to focus X-rays at these high energies.

Sara: So what makes NuSTAR different than, say, Chandra, XMM, Suzaku, these other X-ray telescopes?

Dan: Right, so NuSTAR is essentially the same basic design. The mirrors have the same design as Chandra and XMM but what's different, what's new is that it goes to higher energies or higher frequencies of X-ray light. So what we want to do with NuSTAR is we want to look through obscuring material in the universe and get down and to see what's happening in detail in the objects we're looking at.

Sara: What sort of things will NuSTAR be looking at?

Dan: The primary mission is really to look at black holes and get a census of them both in the universe and to look at the very center of the galaxy and to see the supermassive black hole that's in the center there and all of the star formation that's going on in the immediate vicinity. So one of the interesting things about these black holes is that with Chandra and XMM we've been able to resolve a lot of these black holes that are very far away from us in other galaxies in the universe. But there's still a lot of radiation, there's what's called the cosmic X-ray background which is just this glow in the universe and we don't know for sure where it comes from. We're pretty sure that it comes from these black holes but the numbers don't match so what we see with Chandra, for example, doesn't match what you would expect to see at the higher energies where NuSTAR is sensitive. So the goal here is to resolve as much of that as we can and then to say, okay. these are black holes that are buried deep inside of a galaxy and there's a lot of obscuring material so that we can't see them with Chandra but we can see them with NuSTAR.

Sara: So what part did you play in all of this?

Dan: So I came rather late into the mission. So I just got my Ph.D. two years ago now and when I came to Goddard I had a lot of interest in it because my research was looking at the hard X-ray part of the spectrum, and specifically looking at clusters of galaxies. So this was the next mission that was going to have a window into that, this was why I was so interested in getting involved, and it just so happened that when I arrived that they needed someone to help out with the optics calibration. So that was done up at Columbia, they have a calibration facility there that they built explicitly for this purpose on a shoestring budget and did a fantastic job. So I was able to come in that way and help out with that effort.

Sara: So what are you the most excited about with the future of NuSTAR?

Dan: Well so my scientific interest is not one of the primary topics that NuSTAR is looking at so it's one of the ancillary science programs. But it's looking at galaxy clusters. So galaxy clusters are the largest gravitationally bound structures in the universe which, of course, makes them the coolest. Well I should say makes them the hottest, actually. They're extremely hot so what we look at in the X-rays are hot gas that's fallen into these large dark matter potential wells and they're really hot just because there's so much mass there. And so this gas permeates all the space in between the galaxies in the cluster and these massive clusters tend to have thousands of galaxies within a million light-year region of space. And so what we want to see - we want to look for what's called non-thermal radiation. So we know there's this hot thermal gas that's in there but we also know that there's a non-thermal or relativistic population of particles in there. And so these are electrons and protons that are buzzing around essentially at the speed of light. We know they're there because we can see them at radio wavelengths and so far there have been tentative detections of them in the X-ray band. And the emission should be easier to see at hard X-rays which is why NuSTAR is really good for these types of observations. So NuSTAR being the most sensitive telescope at these energies has a really good shot at detecting, really solidly detecting, this emission for the first time.

Sara: What's the mission lifespan like?

Dan: So the initial mission is two years, it's a two year base mission. But after that, I don't think anything's official, but hopefully there will be a guest observer program. So this means that anyone in the community can propose for observations with NuSTAR and I would like to see that because there are observations that I would like to propose in addition to the ones we're planning on doing now. And so that could last another year maybe two years, it's unclear. It would depend a lot on how successful NuSTAR is. And so far, it seems to be hitting all of the benchmarks. So hopefully it'll last for many more years to come.

Sara: We're certainly excited to find out what NuSTAR will see! It celebrated 100 days on orbit in September, and has been making its first observations of black holes. NuSTAR has also been teaming up to make coordinated observations with other satellites, such as Chandra and Swift.

To learn more about NuSTAR and other science coming out of NASA's Astrophysics missions, visit our website at universe.nasa.gov/blueshift

You can also find us on Twitter or Facebook, where we're NASAblueshift, that's all one word. Send us your questions about astrophysics, and let us know what you want to know more about! I'm Sara Mitchell, bringing the Universe closer to you with Blueshift.

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