Ask an Astronomer

Question: "Why aren't there any green stars?"
segment number: 2008-002

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When we first look into the night sky, it seems like all the stars are glowing faintly white, but a closer look reveals that some are tinted blue or yellow or even orange. But why aren't there any green stars, or for that matter, purple ones? The answer to that actually has a lot more to do with how our eyes work than anything that's going on with the stars.

Amazingly, all matter in the universe gives off light at every wavelength from gamma rays to radio, but we give off a lot more of certain kinds of light based on our temperature.

This is called black-body radiation, and a graph of how much light comes at each temperature is called an object's black-body curve. The black-body curve peaks at different wavelengths depending on its temperature. Higher energy light has shorter wavelengths, so the higher an object's temperature shorter the wavelength light its black-body curve peaks at.

Cool objects – like planets, brown dwarfs, even you and me – peak in infrared light. Hotter objects glow in visible light. And some objects, like the inner disks around black holes or gamma-ray bursters, are so hot that they actually shine in X-ray or gamma-ray light.

But the human eye isn't a scientific instrument that precisely measures the wavelength of the light entering it. We're a bit more... organic. The normal human eye sees light with special cells on the retina called rods and cones. The cones are the ones that are sensitive to color.

Each cone is sensitive to either red, blue, or green light, and the colors that we see are actually made up of a combination of these three primary colors. Our brain does the interpreting.

But we're not actually sensitive to all the colors equally -- we see green light a lot better because it also triggers a little bit of the red and blue cones -- and since the cones are sensitive over a range of wavelengths, it's hard for us to know exactly what wavelengths we're looking at.

So, when we superimpose a black-body curve on the range of light that we can see, you'll notice that a cooler star looks red because the

leading edge of the black-body curve is visible. A really hot star looks blue, because the trailing edge of the black-body curve shines more brightly on the blue end of the spectrum than on the red end.

But if a star is exactly the right temperature to peak at the wavelength we see as green, well, the black-body curve also triggers the red and the blue cones, and we kind of see it as white. In truth, our own Sun peaks in the yellow-green part of the spectrum, but it doesn't look very green to us.

And remember my question about purple stars? Well, the most massive stars in the Universe are so hot that they actually peak in the ultraviolet part of the spectrum. But our eyes are just not very sensitive in purple light, so these stars look more blue to us than anything else, and stars that really peak in the green basically look white.

Realistically, stars come in every color, it's just that we don't see them that way because of a fluke of how our eyes evolved. For "Ask an Astronomer," I'm Dr. Michelle Thaller at the Spitzer Science Center.