Naked Eye Observations: Crash Course Astronomy #2

Crash Course: Astronomy
https://youtube.com/watch?v=L-Wtlev6suc
https://nerdfighteria.info/v/L-Wtlev6suc

(0:03)
Hey, Phil Plait here. Welcome to episode 2 of Crash Course Astronomy: Naked Eye Observations.

Despite the salacious title, nudity is not required. In fact, given that a lot of astronomical observations are done at night, you may want to bundle up.

(0:17)
Intro

(0:27)
As it relates to astronomy, “naked eye” means no binoculars, no telescope. Just you, your eyeballs, and a nice, dark site from which to view the heavens. After all, that’s how we did astronomy for thousands of years, and it’s actually pretty amazing what you can figure out about the Universe just by looking at it.

(0:43)
Imagine you’re somewhere far away from city lights, where you have an unobstructed view of the cloudless sky. The Sun sets, and for a few minutes you just watch as the sky darkens. Then, you notice a star appear in the east, just over a tree. Then another, and another, and within an hour or so you are standing beneath an incredible display, the sky spangled with stars.

(1:04)
What do you notice right away?

First, there are a lot of stars. People with normal vision can see a few thousand stars at any given time, and if you want a round number, there are very roughly six to ten thousand stars in total that are bright enough to detect by eye alone, depending on how good your sight is.

(1:19)
The next thing you’ll notice is that they’re not all the same brightness. A handful are very bright, a few more are a bit fainter but still pretty bright, and so on. The faintest stars you can see are the most abundant, vastly outnumbering the bright ones.

(1:31)
This is due to a combination of two effects. One is that stars aren’t all the same intrinsic physical brightness. Some are dim bulbs, while others are monsters, blasting out as much light in one second as the Sun does in a day.

(1:44)
The second factor is that not all stars are the same distance from us. The farther away a star is, the fainter it is. Interestingly, of the two dozen or so brightest stars in the sky, half are bright because they’re close to Earth, and half are much farther away but incredibly luminous, so they still appear bright to us.

(2:00)
This is a running theme in astronomy and science in general. Some effects you see have more than one cause.
Things aren’t always as simple as they seem.

(2:09)
The ancient Greek astronomer Hipparchus is generally credited for creating the first catalog of stars, ranking them by brightness. He came up with a system called magnitudes, where the brightest stars were 1st magnitude, the next brightest were 2nd magnitude, down to 6th magnitude. We still use a variation of this system today, thousands of years later.

(2:27)
The faintest stars ever seen (using Hubble Space Telescope) are about magnitude 31 – the faintest star you can see with your eye is about 10 billion times brighter!
The brightest star in the night sky — called Sirius, the Dog Star — is about 1000 times brighter than the faintest star you can see.

(2:45)
Let’s take a closer look at some of those bright stars, like, say, Vega. Notice anything about it? Yeah, it looks blue. And Betelgeuse looks red. Arcturus is orange, Capella yellow.

(2:55)
Those stars really are those colors. By eye, only the brightest stars seem to have color, while the fainter ones all just look white. That’s because the color receptors in your eye aren’t very light-sensitive, and only the brightest stars can trigger them.

(3:09)
Another thing you’ll notice is that stars aren’t scattered evenly across the sky. They form patterns, shapes. This is mostly coincidence, but humans are pattern-recognizing animals, so it’s totally understandable that ancient astronomers divided the skies up into constellations — literally, sets or groups of stars — and named them after familiar objects.

(3:27)
Orion is probably the most famous constellation; it really does look like a person, arms raised up, and most civilizations saw it that way. There’s also tiny Delphinus; it’s only 5 stars, but it’s easy to see it as a dolphin jumping out of the water. And Scorpius, which isn’t hard to imagine as a venomous arthropod.

(3:44)
Others, well, not so much. Pisces is a fish? Yeah, OK. Cancer is a crab? If you say so.

(3:51)
Although they were rather arbitrarily defined in ancient times, today we recognize 88 official constellations, and their boundaries are carefully delineated on the sky. When we say a star is in the constellation of Ophiuchus, it’s because the location of the star puts it inside that constellation’s boundaries. Think of them like states in the US; the state lines are decided upon by mutual agreement, and a city can be in one state or the other.

(4:15)
Mind you, not every group of stars makes a constellation. The Big Dipper, for example, is only one part of the constellation of Ursa Major, the Big Bear. The bowl of the dipper is the bear’s haunches, and the handle is its tail. But, bears don't have tails! So astronomers might be great at pattern recognition, but they're terrible at zoology.

(4:34)
Most of the brightest stars have proper names, usually Arabic. During the Dark Ages, when Europe wasn’t so scientifically minded, it was the Persian astronomer Abd al-Rahman al-Sufi who translated ancient Greek astronomy texts into Arabic, and those names have stuck with us ever since.

(4:50)
However there are a lot more stars than there are proper names, so astronomers use other designations for them. The stars in any constellation are given Greek letters in order of their brightness, so we have Alpha Orionis, the brightest star in Orion, then Beta, and so on. Of course, you run out of letters quickly, too, so most modern catalogs just use numbers; it’s a lot harder to run out of those.

(5:11)
Of course, just seeing all those faint stars can be tough… which brings us to this week’s “Focus On.”

(5:16)
Light pollution is a serious problem for astronomers. This is light from street lamps, shopping centers, or wherever, where the light gets blasted up into the sky instead of toward the ground. This lights the up the sky, making fainter objects much more difficult to see.

(5:30)
That's why observatories tend to be built in remote areas, as far from cities as possible. Trying to observe faint galaxies under bright sky conditions is like trying to listen to someone 50 feet away whispering at you at a rock concert.

(5:43)
This affects the sky you see as well. From within a big city it's impossible to see the Milky Way, the faint glowing streak across the sky that's actually the combined light of billions of stars. It gets washed out with even mild light pollution.

(5:56)
Your view of Orion probably looks like this:

When from a dark site it looks like this:

(6:01)
It's not just people who are affected by this, either. Light pollution affects the way nocturnal animals hunt, how insects breed, and more, by disrupting their normal daily cycles.

(6:11)
Cutting back light pollution is mostly just a matter of using the right kind of light fixtures outside, directing the light down to the ground.

(6:17)
A lot of towns have worked to use better lighting, and have met with success. This is due in large part to groups like the International Dark-Sky Association, GLOBE at Night, The World at Night, and many more, who advocate using more intelligent lighting, and to help preserve our night sky.

(6:33)
The sky belongs to everyone, and we should do what we can to make sure it's the best possible sky we can see.

(6:39)
Even if you don't have dark skies, there's another thing you can notice when you look up. If you look carefully, you might see that a couple of the brightest stars look different than the others. They don't twinkle! That's because they aren't stars, they're planets.

(6:51)
Twinkling happens because the air over our heads is turbulent, and as it blows past, it distorts the incoming light from stars, making them appear to slightly shift position and brightness several times per second. But planets are much closer to us, and appear bigger, so the distortion doesn't affect them as much. There are five naked eye planets (not counting Earth): Mercury, Venus, Mars, Jupiter, and Saturn. Uranus is right on the edge of visibility, and people with keen eyesight might be able to spot it. Venus is actually the third brightest natural object in the sky, after the Sun and Moon. Jupiter and Mars are frequently brighter than the brightest stars, too.

(7:25)
If you stay outside for an hour or two, you'll notice something else that's pretty obvious: the stars move, like the sky is a gigantic sphere wheeling around you over the course of the night.

(7:35)
In fact, that's how the ancients thought of it. If you could measure it, you'd find this celestial sphere spins once every day. Stars toward the east are rising over the horizon, and stars in the west are setting, making a big circle over the course of the night (and presumably, day). This is really just a reflection of the Earth spinning, of course. The Earth rotates once a day, and we're stuck to it, so it looks like the sky is spinning around us in the opposite direction.

(7:59)
There's an interesting thing that happens because of this. Look at a spinning globe. It rotates on an axis that goes through the poles, and halfway between them is the Equator.

(8:06)
If you stand on the Equator, you make a big circle around the center of the Earth over a day. But if you move north or south, toward one pole or the other, that circle gets smaller. When you stand on the pole, you don't make a circle at all; you just spin around in the same spot.

(8:20)
It's the same thing with the sky. As the sky spins over us, just like with the Earth, it has two poles and an Equator. A star on the celestial Equator makes a big circle around the sky, and stars to the north or south make smaller ones. A star right on the celestial pole wouldn't appear to move at all, and would just hang there, like it was nailed to that spot, all night long.

(8:38)
And this is just what we see! Photographic time exposures show it best. The motions of the stars show up as streaks. The longer the exposure, the longer the streaks as the stars rise and set, making their circular arcs in the sky.
You can see stars near the celestial equator making their big circles. And, by coincidence, there's also a middling-bright star that sits very close to the north celestial pole. That's called Polaris, the north or pole star. Because of that, it doesn't appear to rise or set, and it's always to the north, motionless. It really is coincidence; there's no southern pole star, unless you count Sigma Octantis, a dim bulb barely visible by eye that's not all that close to the south pole of the sky, anyway.

(9:16)
But even Polaris isn't exactly on the pole -- it's offset a teeny bit. So it does make a circle in the sky, but one so small you'd never notice. By eye, night after night, Polaris is the constant in the sky, always there, never moving.
Remember, the sky's motion is a reflection of the Earth's motion. If you were standing on the north pole of the Earth, you'd see Polaris at the sky's zenith — that is, straight overhead — fixed and unmoving. Stars on the celestial equator would appear to circle the horizon once per day. But this also means that stars south of the celestial equator can't be seen from the Earth's north pole! They're always below the horizon.

(9:51)
So this in turn means that which stars you see depends on where you are on Earth. At the north pole, you only see stars north of the celestial equator. At the Earth's south pole, you only see stars south of the celestial equator. From Antarctica, Polaris is forever hidden from view. Standing on the Earth's equator, you'd see Polaris on the horizon to the north, and Sigma Octantis on the horizon to the south, and over the course of the day the entire celestial sphere would spin around you; every star in the sky is eventually visible.

(10:19)
While Polaris may be constant, not everything is. Sometimes you

just have to wait a while to notice. And to that point, you'll have to wait a while to find out what I mean by this because we'll be covering that in next week's episode.

(10:30)
Today we talked about what you can see on a clear dark night with just your eyes: thousands of stars, some brighter than others, arranged into patterns called constellations. Stars have colors, even if we can't see them with our eyes alone, and they rise and set as the Earth spins. You can see different stars depending on where you are on Earth, and if you're in the northern hemisphere, Polaris will always point you toward north.

(10:52)
Crash Course is produced in association with PBS Digital Studios. This episode was written by me, Phil Plait. The script was edited by Blake de Pastino, and our consultant is Dr. Michelle Thaller. It was co-directed by Nicholas Jenkins and Michael Aranda, and the graphics team is Thought Café.