Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *The celestial sphere.*

When you live on the surface of a big round planet that's spinning round and around on its axis you experience an optical illusion that can make you think you are standing still and it's the sky that's actually spinning overhead. For example…(*sound byte*).

Of course there's always two points in the night sky that don't spin, namely the northern and southern celestial poles – one being near Polaris and the other one being pointed at by the Southern Cross.

If you walked to the northern terrestrial pole, Polaris would be directly overhead, which we call 90 degrees altitude. But otherwise, in lower latitudes, Polaris will be lower in the sky – indeed in the northern hemisphere its altitude will match your latitude – so that at Montreal in Canada which is at latitude 45 degrees north, Polaris will be due north at 45 degrees altitude in the sky, all night and every night while the rest of the sky appears to spin around it. Walk to the equator and Polaris will still be due north but down on the horizon – which is 0 degrees altitude. And (small astronomy joke here) there will be a noticeable lack of circumpolar stars.

All this talk of altitude leads me to tell you about one type of telescope mount, an alt-azimuth mount – utilised in some of the world's cheapest telescopes, Dobsonians, as well as some of the world's largest – and most expensive – radio telescopes, like the 100 metre diameter Green Bank telescope in West Virginia – mountain momma, take me home.

If you have an alt-azimuth mount and you want to look at Polaris – and say you happen to live in Montreal Canada – you just swivel the rotating 360 degree azimuth base of your telescope mount around to due north – and then you raise your telescope to point at 45 degrees altitude – and voila Polaris will be smack in the middle of your field of view.

Trouble is though… try and ring some friends in Uzbekistan and suggest they adjust their telescope to zero degrees azimuth and 45 degrees altitude, it ain't Polaris they'll be looking at.

Wouldn't it be great if there was some kind of universal co-ordinate system where you could ring up a fellow astronomer anywhere on the surface of the Earth – and just give them a couple of numbers so that they could quickly find the same thing that you are looking at.

Well, this is where it becomes extremely useful – for astronomical and navigational – and even time-keeping purposes – to just embrace our shared global optical illusion and pretend that the night sky really is a big celestial sphere that rotates about the Earth.

So … as well as having poles, the great spinning celestial sphere has an equator – which is a line running east-west directly overhead when you are at the Earth's equator. If you are further south, it's always in the northern sky – and if you are further north, it's always in the southern sky.

Because of the Earth's axial tilt to the plane of the solar system – there's only two times in the Earth's orbit – that is, two times a year - when the Sun crosses the equator. These are of course the equinoxes, because it then that both the northern and southern hemispheres get equal amounts of the sun's heat and light.

Back in Babylonian times, someone decided we should call the point where the apparent path of the Sun, the ecliptic, crosses the celestial equator in March the zero point – and then from the zero point we start counting eastwards along the celestial equator – but rather than counting by degrees we count by hours – and, big surprise, the celestial equator is divided into units of twenty four hours.

So now you can ring up anyone on Earth and tell them to look at 1 hour along the celestial equator to see the Pisces constellation, or look at 5 hours to see Orion – and anywhere from 8 to 15 hours to see the water snake constellation Hydra and even 23 hours to see Aquarius.

Interestingly, the zero point – currently sitting between Pisces and Aquarius is traditionally called the First Point of Aries – because that's where it used to be, in Aries. But because of the 26,000 year cyclic wobble of the Earth's axis, you get a precession of the equinoxes, so this zero point (representing the March equinox) is now slowly shifting towards Aquarius – though it won't get there until the year 2600 – so that bunch of hippies who thought this is the dawning of the age of Aquarius were perhaps a tad premature.

Astronomers, being the serious folk that they are, substituted the traditional navigation term of hour angle, for a more obscure and scientific sounding term right ascension – but it's stil the same measure of different points along the celestial equator which is still divided into twenty four hours – although if trying to identify a specific star location – we often get down to units of minutes and seconds – and often with a decimal point added to the seconds.

So, right ascension is your measure of celestial longitude but what about latitude? This is where that other term declination comes in – and here we do back to degrees where the celestial equator is zero degrees and then we count up to the northern celestial pole which is 90 degrees and we count down to the southern celestial pole which is minus 90 degrees.

So, if you ever want to tell someone whose telescope is on an equatorial mount where the red supergiant Antares is – well if it's a cheap telescope you could just swing it around and point it at that bright red star in Scorpius. But if they've spent mega bucks on an all-optional-extras scope just type into the Go-To computer – right ascension 16 hours, 29 minutes and 24 seconds and declination minus (because it's to the south of the celestial equator) 26 and a bit degrees (that bit depending on how the system divides up degrees).

But of course, that's only going to work for a while. Remember that business about the precession of the equinoxes? Because of that we have to redefine the zero point every now and again. And on top of this, pretty much everything in the universe is moving. The solar system is slowly make its way around its quarter of a billion years orbit of the galactic centre – and other stars are also moving along various gravitationally defined paths. So not only do we have to recalibrate the right ascension-declination grid every now again, because of the Earth's 2,600 year cyclic wobble, but also – at least for stars with a fast proper motion (like say, Barnard's Star) – we have to keep correcting their position on the grid.

Right now, astronomers follow a coordinate system based on how everything was on the 1st of January in the year 2000 – also known as the J2000 epoch. So, in the case of Barnard's star, you could sound really knowledgeable by saying – oh, I think it's just up and to the right a bit of J2000. If previous update schedules are adhered to, we can expect a new astronomical epoch, with updated equinoxes and updated star positions, to be established in 2050.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where you can just point your telescope at something and have a look. No ads, no profit, just good science. Bye.