

The Transient Universe

Spring is back for its yearly engagement. Wildflowers are visible on many hills and gardens as also along many freeways. Just by looking around one knows its spring. It's like clockwork. Astronomers are after such clockwork and after change visible on the backdrop of the clockwork.

Here are a couple of memories from childhood. While growing up I spent a few years each in many different places. When I was just a few years old, I was in Yavatmal. I still have otherwise vague memories from then, but a few strongly stand out. During summer, for instance, the temperatures would rise, and cotton stored at the gins on the outskirts of the town (near the appropriately enough named 'ginaatalaagaNapati') would catch fire. The fire trucks from Yavatmal and from several nearby towns would rush through the streets screaming. It was a break from the usual and is forever etched into memory. Several years later, I spent a few years of my highschooling in Chandrapur, and we lived not far from the otherwise ordinary Ira river. With friends I would sometimes cycle down to the banks and look at the small bed. During monsoon the picture could drastically change though. While not regular, flooding was not unheard of. The southern California fires and flash-floods are quiet in line with these earlier experiences. Another break from the usual. These breaks are of course on the backdrop of the yearly clockwork (summer, spring, monsoon etc. in these cases).

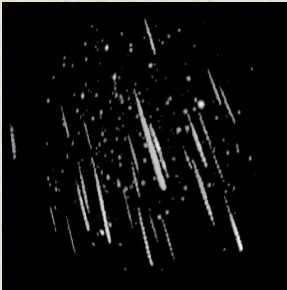
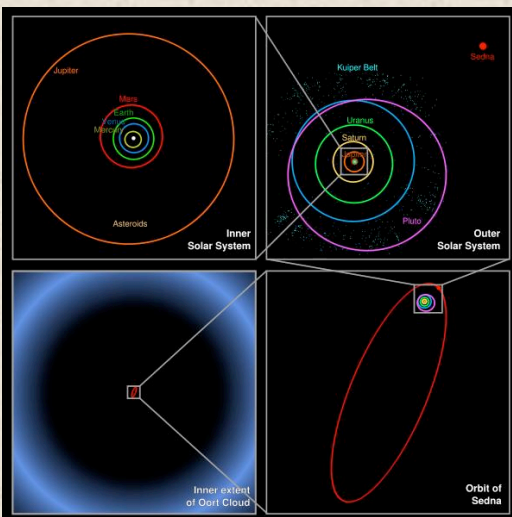


Figure 1 : Meteors from a video superimposed. During a good shower one can see meteors at a good rate, but depending on various factors the directions can vary a bit. Image courtesy: International Meteor Organization.

Meteor showers reflect a similar phenomenon. Orbits of various comets intersect the orbit of Earth and leave debris in form of particulate matter behind. During its annual journey around the sun when the Earth passes these points, the debris enters Earth's atmosphere, and as it falls towards the ground the friction in the air causes it to heat up and burn spectacularly. Only the biggest of chunks manage to survive the trip to the surface of the Earth and are called meteorites. Seeing meteors is not unusual - on any night you can see some. But if you are lucky enough to see a fireball from a meteorite, don't shout with joy. If you stay quiet, you may hear the rarer and as yet mysterious sound it makes during the process. The annual calendar here <http://www.imo.net/docs/cal2010.pdf> shows the dates for meteor showers in 2010.

It is the biggest meteorites, or what are called bolides etc., that can be really destructive. It is such bodies that have caused craters like Lonar lake in Maharashtra, Crater lake in Oregon, as well as the relatively recent Tunguska event (1908). Even the dinosaurs are likely to have been sent to extinction by such an event 65 million years ago. But these bigger events were likely caused by straying asteroids.



Besides planets and their satellites, comets and asteroids are also part of solar families. Most of us are familiar with the asteroid belt between Mars and Jupiter. But farther out there are other populations of bodies much smaller than planets and yet held in captivity by the sun. Only recently has our understanding of all these families been steadily improving. We can, from a few observations, determine the orbits of these bodies. These studies also help us determine if any of the asteroids are heading our way. If one is on a collision course there are still only limited things we may be able to do. An interesting possibility, for instance, is to paint just one side of the asteroid. It will make it reflect more light and differentially heat it resulting in increased rotation and change of orbit thus making it miss Earth.

Figure 2: This series of insets shows the variety that exists within our Solar System as well as its extent relative to Earth's orbit. Courtesy Wikipedia

The planets too were discovered due to a change (with respect to the stars). The stellar background is fairly constant. As the Earth rotates, the stars seem to go around the Earth. As the Earth slowly revolves around the sun, the stars seem to rise at different times, but they do not seem to move relative to each other. It is against this backdrop that certain objects were found to move. These were called planets (wanderers in Greek). Astronomers got interested in those - why do they move, how do they move etc. We then discovered that we also live on such a wanderer.

Now we are in a position to look for planets around other stars. Initially most such planets will be like Jupiter (big, more distant from the sun compared to Earth and hence more easily discernible). But soon we should start finding Earth-like planets. Already we are finding several super-earths (these have mass in between that of Earth and Jupiter and say nothing about whether life will survive on them).

Astronomers are after another kind of change which has nothing to do with motion, either relative or absolute. These are intrinsic changes in the brightness of an object. All stars vary to an extent. Amateur astronomers often obsess about variable stars. Meticulous observations of these are useful in characterizing the types of stars - and their is a spectacular variety in these.

For those who do not have large telescopes here is a recent article with information about naked eye variables - stars you can see varying with the naked eye (several observations are of course needed):

<http://www.skyandtelescope.com/observing/home/3304276.html>

Some of the changes can be spectacular. If you look at old art, you will realize that all peoples have been fascinated by such transients. There are various comets, nebulae that are drawn. Even in Mahabharat there is the reference to something like a total solar eclipse (this is extrinsic variability though - the sun's brightness is not varying, but just seems to because the moon steps in between). Crab nebulae, star of Bethlehem and so on. These things, the changes, were clearly given a lot of importance. Some of these are example of supernovae - stars that explode to put themselves out of existence. Thankfully none has happened close enough to us.

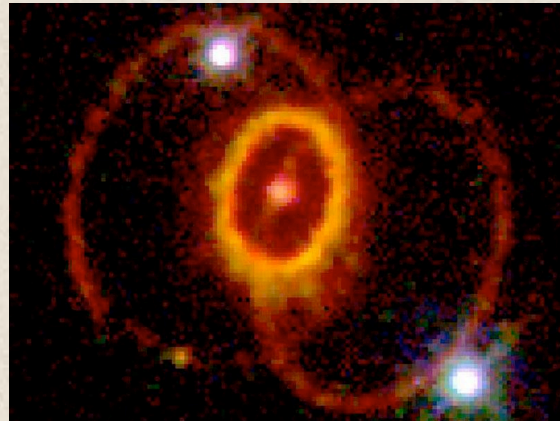
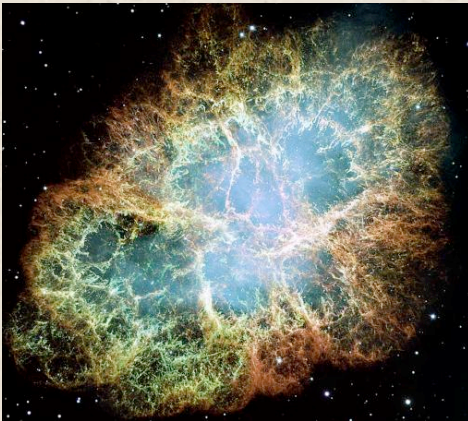


Figure 3: Two spectacular supernovae. Crab of the left (also M1 or first object of the Messier catalog) has records from 1054. On the right is 1987a that happened not too far from us. These days SN are so numerous, that they are known by the year they were discovered in followed by successive letters, pairs of letters etc. Catalina Sky Survey on which I work has discovered over 300 SN in recent times.

Which stars will be stable, that we learn from understanding which stars are not stable. One day we will have to move out and stay on a planet that moves round some other star. Besides other thing these studies will also tell us which type of star not to choose.

There are other phenomena that occur outside our galaxy and are violently variable. We will see those later.

-Ashish Mahabal