Grade 9 Planetarium Presentation

Time: 30-45 minutes total time inside the dome

Sky Maps: Current sky maps can be used to help prepare for these presentations. They can be obtained at the BBC science web site: http://www.bbc.co.uk/science/space Click the "My Space" link on the left column, then choose "Sky Maps and Notes" from the centre frame.

Goals: Introduce students to how the stars move around in the sky over the course of a day and from day to day. Show how position and apparent motion are affected by one's location on the earth. Students will learn to identify major constellations visible around the date of the presentation. Students also will learn to identify the major stars visible to the un-aided eye. Stars will be used to demonstrate the relationship between colour and temperature; luminosity, distance, and brightness; the concept of the light year; the size range of stars; and the relationship between size, temperature, and luminosity. The effects of light pollution in cities will be addressed. The students will get practice at estimating the number of stars visible to the un-aided eye. If time permits, students will be shown where to find major nebulas, the Andromeda galaxy, the black-hole Cygnus-X1, and how the solar system is oriented within our Milky Way Galaxy and where to look for the center and outer edge.

Set Up

1) Load the constellations cylinder.
2) Set tilt on lamp to match Ottawa's latitude, about 45 degrees.
3) Orient projector so that Polaris is reasonably close to the north direction.
4) Rotate the cylinder to show the sky at 10 PM on or about the current date.
   For late May, the big dipper should be above the little dipper (the big dipper should be near the top of the dome) and Cassiopeia should be under the big dipper near the horizon.
   This will be our reference view for most of the presentation.

While dome is re-inflating and before fan is switched to low power setting

5) Get the students seated.
6) Turn off the side lamps and turn on the projector lamp.

As their eyes are adjusting, go over the parts of the sky:

   a) show them where north is
      ask the name of student that is at the north position of the dome
   b) show them where south, east, and west are (west and east spell out the word "we" if you are facing north).
   c) ask them if they know what the top of the sky is called (the point directly over your head); make sure that everyone knows it is called the "zenith"
   d) ask them the name for the line where the earth and the sky meet (horizon), hopefully they all know it.

Constellations Cylinder

7) Describe what they are seeing: the major stars only with lines showing the formal constellations
8) Point out the asterisms big and little dippers and the star Polaris.

Ask them what is special about polaris:

   a) conclude that the earths rotation axis points almost exactly to polaris.
      this is why polaris is always to the north.
   b) verify this by slowly spinning the cylinder (careful, serious regurgitation is possible) while keeping the light pointer on polaris.

Point out the line marking the equator and the ecliptic. They are not the same lines because

the earth's rotation axis is tilted about 23 degrees relative to the rotation plane of the solar system. With luck, they have gone over this already.

Ask them what the stars would appear to do as the earth spins on its axis.

If you need to, point out that the earth spins counter clock-wise (when viewed from the north) (west to east, that is)

Conclude, that like the sun, the stars will rise in the east move across the sky and set in the west (counter-clockwise if looking north, clockwise if looking south). Demonstrate by slowly spinning the cylinder in a clock-wise direction.

9) a) If you have time, turn out the projection lamp, re-tilt the cylinder so that polaris is at the Zenith, turn the lamp back on.

Ask the class where on earth we must be if Polaris is directly over head.

Conclude that we are at the north pole.

Point out that the equator line is at the horizon.

Ask them what the stars will appear to do in the sky as the earth rotates.

Demonstrate by spinning the cylinder clock-wise.

Point out that polaris does not appear to move much. (keep your light pointer on it)

The stars rotate around parallel to the horizon.

b) Turn out the lamp, re-tilt the cylinder so that polaris is at the horizon, turn the lamp back on.

Ask the class where on earth we must be if polaris is at the horizon.

Conclude that we are on the equator

Point out that the equator line passes directly through the Zenith

Ask them what the stars would appear to do in the sky as the

Demonstrate by spinning the cylinder clock-wise.

Point out that polaris does not appear to move much. (keep your light pointer on it)

The stars rise in the east, move directly towards and set in the west.

Ask them if we could see polaris if we were south of the equator.

Conclude that we could not, since it would be below the horizon; blocked by the earth.

10) Turn out the lamp, re-tilt the cylinder for a 45 degrees latitude, turn the lamp back on Point out that since we are about half way between the equator and the north pole, that polaris is about half way between the Zenith and the horizon.

11) a) Go over the major constellations and asterisms and how to find them
Start with the **big dipper**
Show how to use the pointer stars to find the **little dipper**, **Cassiopeia**, **Cepheus**, **Cygnus**, and **Draco**.

b) Show how to measure angles with you fist (10 degrees) and finger (1 degree) at arms length.

c) imagine pouring water out of the cup of the big dipper.
follow the line of the pointer stars in that direction
polaris is about 30 degrees from the near pointer star, or about three fists
d) Cepheus is about 1.5 to 2 more fists past polaris
e) Take a 90 degrees right turn at Cepheus, Cassiopeia is 1.5 fists in that direction.
f) Draco's tail starts half way between the cups of the little and big dipper. Draco curls around the cup of polaris back towards Cepheus and then doubles back on itself towards its pointy head.

g) Talk about how Cepheus looks like he has a really big (swelled) square head and a party hat rather than a crown, since kings like to party a lot. Talk about how Cassiopeia looks like a person sitting on a throne, but with really big feet. She is facing Cepheus, ready to give him a good kick with her big feet when he gets too wild with his partying.

h) Cygnus is on the opposite side of Cepheus from Cassiopeia. If you start from the top of Cepheus' pointy head and draw a line straight down through the middle of his neck (if he had one) and go along this line for another 1.5 fist widths, you come to Deneb, the bright star in Cygnus.

12) The previous constellations can be seen at any time of year. The southern constellations change from season to season. This is because we only can see stars when out part of the earth is facing away from the sun. However, because the earth revolves around the sun, we are facing a different direction when we rotate opposite to the sun each season.

a) To face the opposite direction, follow the line from Cassiopeia up through the little dipper and the big dipper and around to the south.

b) We should show them: Leo, Gemini, Bootes, Virgo, and Canis Minor and we can rotate the cylinder a counter-clockwise bit to show them Orion (the prominent winter constellation) and Canis Major and clock-wise to show them Sagittarius and Scorpius. The other constellations (Cancer, Libra) are not easy to see in the sky as their stars are not as prominent.

c) You can point out that when you look between Sagittarius and Scorpius you are looking towards the center of our galaxy. That is why the faint background stars are so numerous in this direction.

13) Give them some practice by either pointing to constellations at random or by passing around the pointer and asking them to point to constellations. You can decide which based on how much time you have and how the class behaves.

14) Put up the urban star field. Talk about light pollution and how it affects the ability to see stars. Practice identifying constellations. Give them the same practice as in 13.

15) Put up the main star-field cylinder. It shows about 3000 stars. Give them the same practice at finding constellations.
16) Point out the position of Jupiter (near Spica), Saturn (in Cancer), and Mars (in Gemini).
17) Talk about the following stars:
a) Polaris, Arcturus, Antares, Rigel, Castor and Pollux, Spica, Deneb, Betelgeuse, and Sirius.
b) Polaris: an orange giant, also a cephied variable (tell them about cephied variables)
c) Antares is red, Arcturus is orange, Sirius is yellow, and Rigel and Spica are blue. What does this mean about their temperatures?
d) Deneb (in Cygnus) and Sirius (in Canis Major). Sirius is very bright but is not a very luminous star - sort of average much like our sun. However, it is very close (8.5 light years) so it seems bright. Deneb does not seem especially bright, but it is extremely luminous. It only seems dim because it is so far away. If it was as close as Arcturus or Pollux (about 35 light years) it would seem as bright as the moon.

That should get you to the end of the presentation.

Reference Material

Orion is the most obvious constellation in this direction. Show them Orion's belt, two shoulders, knees (skirt), right arm picking out an arrow, and left arm with bow ready to shoot.
Orion's two dogs, **Canis Major** (under the right arm and below Orion's knees) and **Canis Minor** (follow the line from the left shoulder star through the right shoulder star and go about two fists in that direction).
Taurus, the bull (running from Orion), just above Orion's bow (a triangle of stars forms the head)
Gemini, the twins, a mirror image pair of constellations like two people with their arms out in front standing back-to-back. They are just off of Orion's right arm in a direction perpendicular to the upper arm.
Leo, the lion (looks more like a horse). Follow a line from Orion between Gemini and Canis Minor about 6 fists or so. It looks as if it is running after Orion (the hunter is being hunted).
Half-way between Taurus and Cassiopeia is **Perseus**, the hero. He looks like a person leaning forward with one arm curving up behind his back (well, sort of).
Perseus rescued (almost) his girl friend **Andromeda** (Daughter of Cassiopeia and Cepheus) from Hades (Hell). Andromeda looks like a big, upper-case "A" with the base of the "A" half way between Perseus and Cassiopeia. The "A" is pointing in the direction away from the big dipper.

Rotate the cylinder so that it is early evening (Orion is on the eastern horizon)
Cygnus, the swan. The bright star forming the tail of the swan can be found by following a line from Polaris just behind the head of Cepheus (the side away from Cassiopeia) about 2 fists past the base of Cepheus' skull.
Lyra, a small kite-like constellation just one fist off of Draco's nose. The bright star is Vega.
Bootes, the herdsman (ice cream cone). Follow the arc of the handle of the big dipper for twice more its length to find Arcturus at the base of Bootes.
Virgo, the maiden can be found by following the arc of the dipper's handle another two lengths to find Spica.
Scorpio, follow the tail of Cygnus for twice Cygnus's length to get to Antares
Sagittarius, the archer (the tea pot) just to the left of the tail of Scorpio.

Have the students practice identifying the constellations
Star Motion
Show that Orion will be at the eastern horizon at sun-set. It will rise up into the southern sky and will be chased by Leo which rises when Orion is high in the sky. By 4 AM, when they are just finishing their home work, Orion will have set, and Leo will be high in the sky.
The stars near the equator move about 1.5 fists across the sky per hour.
Demonstrate by rotating the cylinder.

As the earth revolves around the sun the stars positions, at a given time of night, also will shift. They move about 3 fists per month, from the east to the west, or about as far as they move in two hours on a given night. So, Orion at midnight on February 1st is in the same position that it was at 10 PM on January 1st. **Demonstrate by rotating the cylinder**.

For constellations near the horizon, we can only see them at certain times of year. Winter constellations, like Orion, not visible in the summer because they rise during the day and set

before it is dark enough in the evening. In order to see a constellation, your part of the earth must be facing it at night, not during the day.

Change cylinders to the urban star field

Rotate the cylinder so Orion is due south again.

Briefly explain that city lights wash out the light from the fainter stars. They make the sky brighter, and only the stars that are brighter than the sky can be seen.

Point out that this can make the constellations easier to pick out.

Have students pick out the major constellations

Pass the light pointer around to different students.

Talk them through the same set of directions as explained previously.

Try the same process after all have been found with the sky rotated to a new time of night.

Change cylinders to the dark-sky star field

Ask the students how many stars they think that they can see.

Ask them if they could count them all; conclude that you could not

Ask them how could the number be estimated.

Conclude that you could count a small patch

multiply be how many time the patch would fit in to the whole sky

Try out the method.

Turn on the reading lamp just a bit

Hold hands at arms length with the thumbs and index fingers making a square

should get about 15-20 stars in this space

should estimate that the patch could fit into the sky about 200 times

yields an estimate of 3000-4000 stars

All these stars are in our own galaxy, and fairly close to us (less than a few thousand LY)

(1 LY is the distance light travels in one year (300,000 km/sec for 1 year = 10 trillion km)

(the galaxy is about 100,000 LY across) If the galaxy was drawn on a standard sheet of paper, most of the stars that we see would be contained in an area less than 5 mm across.

For comparison:

if stars were grains of sand, all 3000 that we can see would fit in a thimble

if all the stars in the universe were grains of sand, they would amount to more sand than all the beaches on the earth; if put in rail-road box-cars, the train would be so long, it would take more than three years to travel past a rail-road crossing.

Point out some of the major stars

Betelgeuse (beetle juice)

right shoulder of Orion, 400 LY away

name modified from the original arabic name that meant "armpit of the great one."

red colour: very cool, just over half the temperature of the sun

very large, 1000 times bigger than the sun. If it was our sun, even Mars would be inside the sun

Rigel

left knee of Orion, 800 LY away

blue colour: very hot; more than twice as hot as the sun

a large star, but not as large as Betelgeuse (about 75 time the size of the sun)

is twice as far away as Betelgeuse but seems brighter in the sky because it is more luminous

it is almost 100,000 times more luminous than the sun

Sirius

bright star on the collar of Canis Major
whitish yellow (slightly hotter than the sun)
about the same size as the sun (1.5 times bigger)
the second brightest star in the sky (ask what is the brightest, the correct answer is the sun)
it is much less luminous than Rigel or Betelgeuse (25 times more luminous than the sun)
seems brighter, however, because it is much closer 8.5 LY
the light we see from Sirius today actually left the star when the students entered grade 1
explain brightness: how bright a star appears to us
luminosity: how much light energy the star actually releases

Sirius has a companion star that orbits it like a planet (Sirius B), but it is too faint to see
is a white dwarf, a star that has collapsed after its fuel has run out
is about the same size as the earth, but with a mass similar to that of the sun - very dense

Most solar systems have more than one star - single star solar systems like ours are less common

Capella

the bright star in Auriga, the charioteer, (above Orion and to the back side of Perseus)
is the brightest star in a solar system that has at least 10 known suns

Algol - the demon

the bright star near the foot of Perseus' forward leg (the one towards Andromeda)
consists of a pair of stars - one much dimmer than the other
every 2 days and 21 hours the dimmer star passes right between us and the brighter star
over a four-hour period, you can see Algol dim to about a tenth its normal brightness

Procyon

The bright star in Canis minor
very similar to our sun, about 11 LY away

Regulus

Bright star in Leo, 79 LY away.
Show this to a grandparent on their 79th birthday. Tell them that they light that they are seeing now left the star the year that they were born and for all their life and during all the things that they have done, the light that they are seeing now has been traveling through space towards them.
It is an odd star, being a blue (hot) dwarf star

Castor and **Pollux**

bright stars forming the heads of the twins in Gemini
Pollux is the brighter star, closer to the horizon
Pollux is an orange giant star - cooler than the sun, hotter and smaller than red

Betelgeuse

Pollux is about 35 LY from us

Aldebaran

the bright "eye" in the head of Taurus, the bull

another orange giant star, 68 light years away

it is only half the distance away as all the other stars in the head of Taurus.

the stars in most constellations do not actually form real groups in space

they only appear close together when viewed from earth because they are in the same direction

E.G. Wezen, a bright super-giant star that forms the bum of Canis Major, is over 1800 LY from earth. It is very dim compared to Sirius, in the same constellation, which is only 8.5 LY away.

The **Pleiades** star cluster is an example of a real group of stars close together in space.

Deneb

Name means "tail" in arabic - it is the tail of Cygnus

One of the most luminous of all stars that we can see

only the 13 most bright since it is 3000 LY away

if it was as close as Pollux, it would be as bright as the moon

Vega

the bright star in Lyra

Ask the students if they have ever seen a spinning top.

Ask if it they stay in one orientation or if the spin axis wobbles. They wobble.

Point out that the earth is like a spinning top, and it wobbles too, though much slower.

Right now, the earth's spin axis points to Polaris.

In 12,000 years, the earth's spin axis will point very near Vega, which will be the north star.

Back when the pyramids were being built, the north star was the second star from the end of Draco's tail. We can verify this because of the way that the pyramids are oriented.

Arcturus

The bright star at the base of Bootes.

A orange giant star only 37 LY from earth.

Antares

The bright star at the back of the head of Scorpio.

A very bright red super giant like Betelgeuse

Spica

A hot blue star in the middle of Virgo.

<u>Practice Identifying Stars and Constellations</u>

At this point, you will probably have about 5 minutes or so left.

Spend it giving the students the pointer light and having them find specific stars and constellations.

If you have time left over, you can point out the following objects

<u>Time fillers</u>

Most stars have Arabic names, while the constellations have mostly Greek names.

Merak and Debhe are the pointers in the big dipper (Dubhe is the closer to Polaris)

Bellatrix is the right shoulder of Orion, while Saiph is the left knee
Many stars have no names, just letter designations based on the constellation that they are in.
Cygnus-X1 is a star about half-way along the neck of the Cygnus, the swan. It orbits a blue supergiant star and is the first star that was identified as being a black hole - a star so small and massive that not even light can escape its gravity.

Not all the objects in the sky are stars. The sword of Orion, hanging from his belt, is made up of three bright points. Only the lowest is a star. The middle point is the great nebula of Orion, a vast cloud of dust and gas bigger than several solar systems. From our distance of 1300 LY, it looks like a star, unless you use a telescope. Orion "contains" several other nebulas, the upper point of the sword and the horse-head nebula beside Barnard's star on the belt (one of the closest stars, 6 LY).

The most distant object that can be seen with the naked eye is another galaxy - the Andromeda Galaxy, about 2,000,000 LY from our galaxy. The two stars that form the cross bar of the "A" in the Andromeda constellation (Mirach and Mu) form convenient pointers to the Andromeda galaxy. Follow the line from Mirach to Mu (roughly towards Cepheus) for a distance roughly the same as that between Mirach and Mu. The faint smudge there is the Andromeda Galaxy, a spiral galaxy like our own, but twice as large.

Our own galaxy shows up as a faint hazy band (it looks like a band of spilled milk) across the sky from Cygnus through Cassiopeia, Perseus, and Orion's right arm and between Orion's two dogs. It is not shown on our star-field cylinders

The ecliptic, which goes through Leo, Gemini, and Taurus. The solar system is tilted by 65 degrees relative to the disk of our galaxy. The boundary between Gemini and Taurus points directly away from the centre of the galaxy. The eastern edge of Sagittarius, not visible in the winter, points towards the center of our galaxy. Coma Berenices points directly out from the surface of the galactic disk. Deneb points roughly in the direction that our solar system is moving around the galaxy.