WEST VIRGINIA UNIVERSITY
EBERLY COLLEGE OF ARTS AND SCIENCES
DEPARTMENT OF PHYSICS AND ASTRONOMY
WVU PLANETARIUM AND OBSERVATORY

Mountaineer Skies

Volume 15, Issue 4 planetarium.wvu.edu **October – November – December 2015**

Inside This Issue

Constellation Legend

Ari - Aries the Ram
Tau - Taurus the Bull
Gem - Gemini the Twins
Cnc - Cancer the Crab
Leo - Leo the Lion
Vir - Virgo the Maiden
Lib - Libra the Scales
Sco - Scorpio the Scorpion
Oph - Ophiuchus
Sag - Sagittarius the Archer
Cpr - Capricorn the Sea-Goat
Aqr - Aquarius the Water-Bearer
Psc - Pisces the Fish

In The Sky this Quarter

Visible Planets in the Night Sky

October 1st, 2015

	Const.	Rise	Transit	Set	Mag
Sun		07:16	13:09	19:03	-26.8
Mercury	Vir	07:13	12:57	18:42	4.5
Venus	Leo	03:47	10:22	16:57	-4.4
Mars	Leo	04:27	11:05	17:42	1.8
Jupiter	Leo	05:03	11:30	17:57	-1.6
Saturn	Lib	11:41	16:35	21:30	1.3

November 1st, 2015

	Const.	Rise	Transit	Set	Mag
Sun		06:48	12:03	17:18	-26.8
Mercury	Vir	05:58	11:26	16:54	-0.9
Venus	Leo	02:58	09:10	15:22	-4.2
Mars	Vir	03:01	09:14	15:27	1.7
Jupiter	Leo	02:30	08:50	15;10	-1.7
Saturn	Sco	08:54	13:46	18:38	1.4

December 1st, 2015

	Const.	Rise	Transit	Set	Mag
Sun		07:21	12:09	16:56	-26.8
Mercury	Oph	08:08	12:41	17:13	-0.4
Venus	Vir	03:43	09:17	14:51	-4.1
Mars	Vir	02:32	08:22	14:11	1.5
Jupiter	Leo	00:53	07:08	13:22	-1.8
Saturn	Oph	07:13	12:02	16:52	1.4

Black Holes: A Curious Point in Nature

Black Holes are the remnants of massive stars that end their life with a brilliant supernova. Seemingly impossible to observe directly, black holes are alien in nature compared to more prominent members of the night sky. Contradictory to Isaac Newton's theory of gravitation, black holes are firmly within the bounds of Einstein's relativity, a fact that leads to some interesting results.

Albert Einstein introduced his General Theory of Relativity in the early 20th century. It models gravity as the curvature of spacetime and relates this curvature to the energy/momentum in this spacetime. The mathematics of this theory are contained within the Einstein Field Equations, a set of partial differential equations. These differential equations are non-linear making finding exact solutions difficult. There was, however, a solution to Einstein's field equations found for a non-rotating, uncharged black hole just a month after the introduction of Einstein's theory, by Karl Schwarzschild.

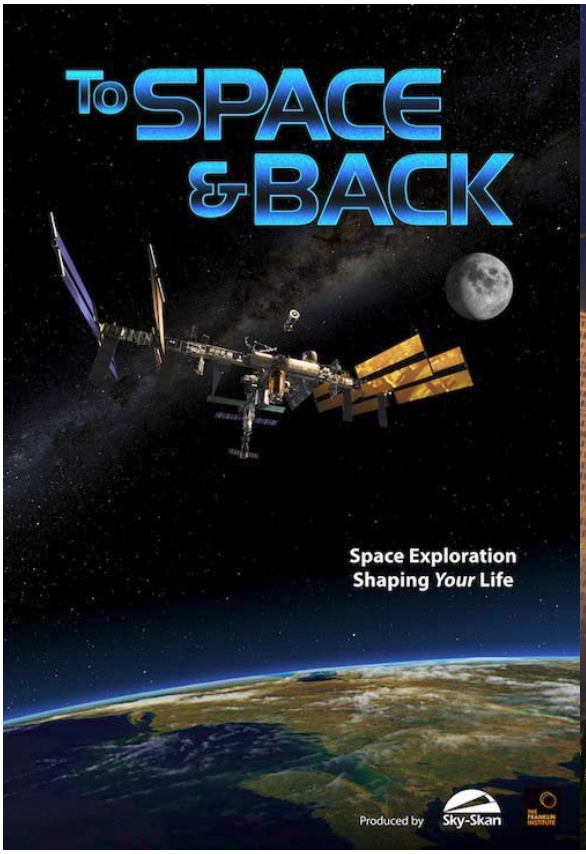
Schwarzschild's solution to the Einstein Field Equations would turn out to be the simplest solution describing a black hole. Still, this model revealed some peculiar properties. One cannot see the point where all the mass of a black hole is located, it is within a boundary called the event horizon. If anything passes within this boundary, it is gone forever as we know it because of a black holes extreme gravity. Not even light, with a traveling velocity of 3x10^8 meters/second, can escape from within the event horizon.

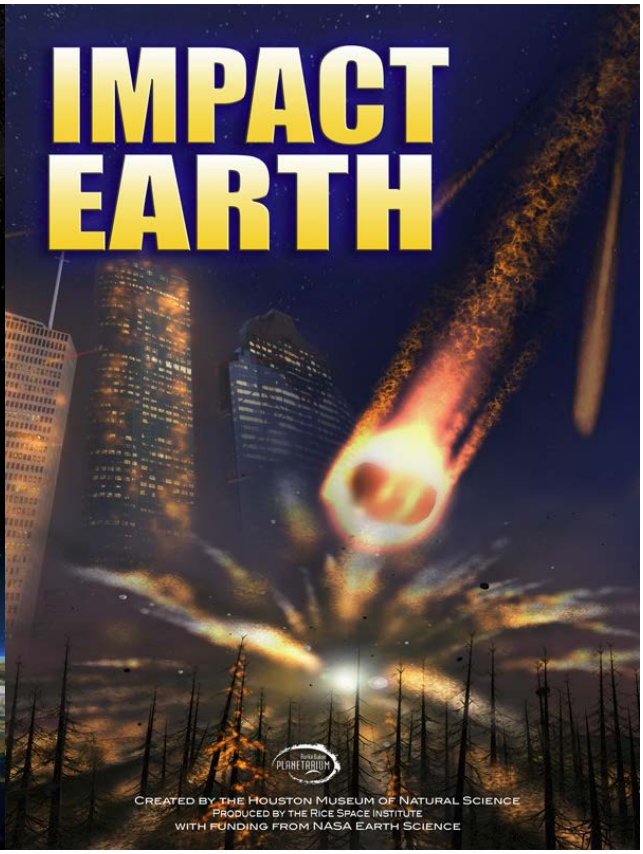
The enormous gravitational force of a black hole would wreak havoc on any future space mission that happens to wander too close. When dealing with massive astronomical objects, the object's tidal forces must be taken into account. A tidal force is a quantification of the difference between gravitational forces at different points of an object; i.e. the force your feet feel as opposed to the force your head feels. Every object in the sky has tidal forces, but sometimes it's not harmful, like on Earth, a pleasant place to live mostly. Instead, look at Jupiter, in our very own solar system. Magnitudes more massive than Earth, the tidal forces close to Jupiter are deadly. Near a black hole, the effects are catastrophic. Any object will be spaghettified, pulled into a microscopic thread of atoms and particles.

Governed by *General* Relativity, black holes have a profound effect on time as well. Years before the introduction of his theory of gravity, Einstein formalized a new theory of time, *Special* Relativity. He showed that time does not run at the same speed for all observers. This idea was carried over to General Relativity with gravitational time dilation. Time will run slower for an observer closer to a black hole. This idea of relativity is very much a part of our everyday life. The satellites that run the multitude of GPS devices we all use did not function correctly until Einstein's relativity was taken into account.

The only physical property a black hole needs to produce the aforementioned effects is mass. This is not the only property black holes have though; they may be charged and have angular momentum as well. In reality, all black holes will have angular momentum, a fact that complicates a black holes properties quite a bit. Too discuss these properties would require multiple more pages so I will end my article here and let everyone ponder these curious objects.

Planetarium Shows





October 9 & 23	**November 13 & 20**	**December 4, 11, & 18**
7:00 P.M. ***To Space & Back***	**7:00 P.M.** ***To Space & Back***	**7:00 P.M.** ***Season of Light***
8:00 P.M. ***Impact Earth***	**8:00 P.M.** ***Impact Earth***	**8:00 P.M.** ***Season of Light***

For those who are interested in bringing a group, such as schools or scouts, during the day, please call Logan Hough at (304) 293-4961 or email at: lhough3@mail.wvu.edu

Selected Sunrise/Sunset and Moon Rise/Moon Set Times

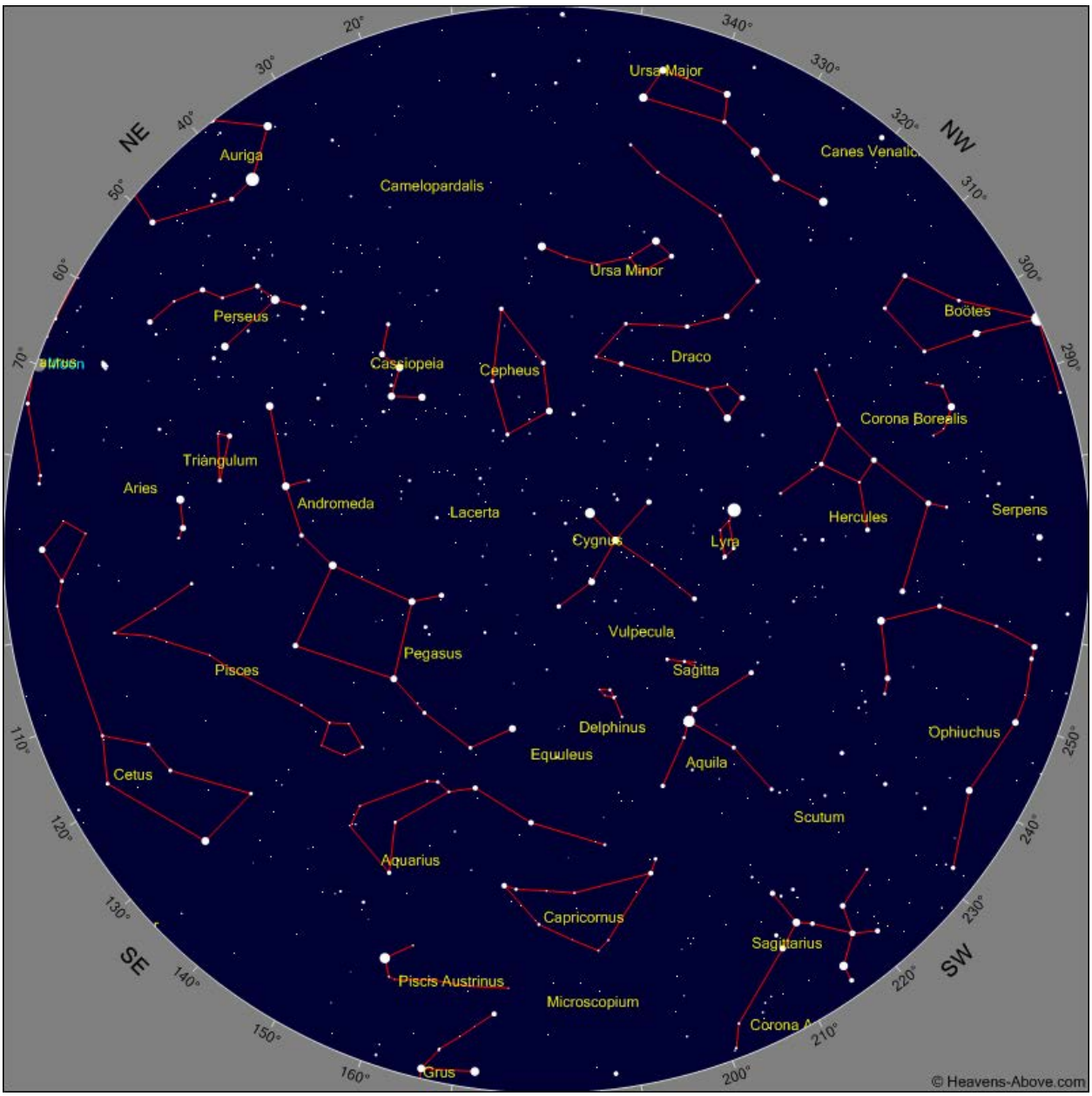
Date	Sunrise	Sunset	Moon Rise	Moon Set	Moon Phase
Oct. 12	07:27	18:45	07:00	18:47	New
Oct. 27	07:43	18:24	18:54	07:39	Full
Nov. 11	06:59	17:08	06:41	17:28	New
Nov. 25	07:15	16:58	17:14	06:36	Full
Dec. 11	07:30	16:56	07:22	17:35	New
Dec. 25	07:39	17:01	17:42	07:25	Full

October 2015 Sky Chart* for:

10:00 P.M. at the beginning of the month

9:00 P.M. in the middle of the month

8:00 P.M. at the end of the month



***Sky Chart used with the kind permission of Heavens-Above at http://www.heavens-above.com/**

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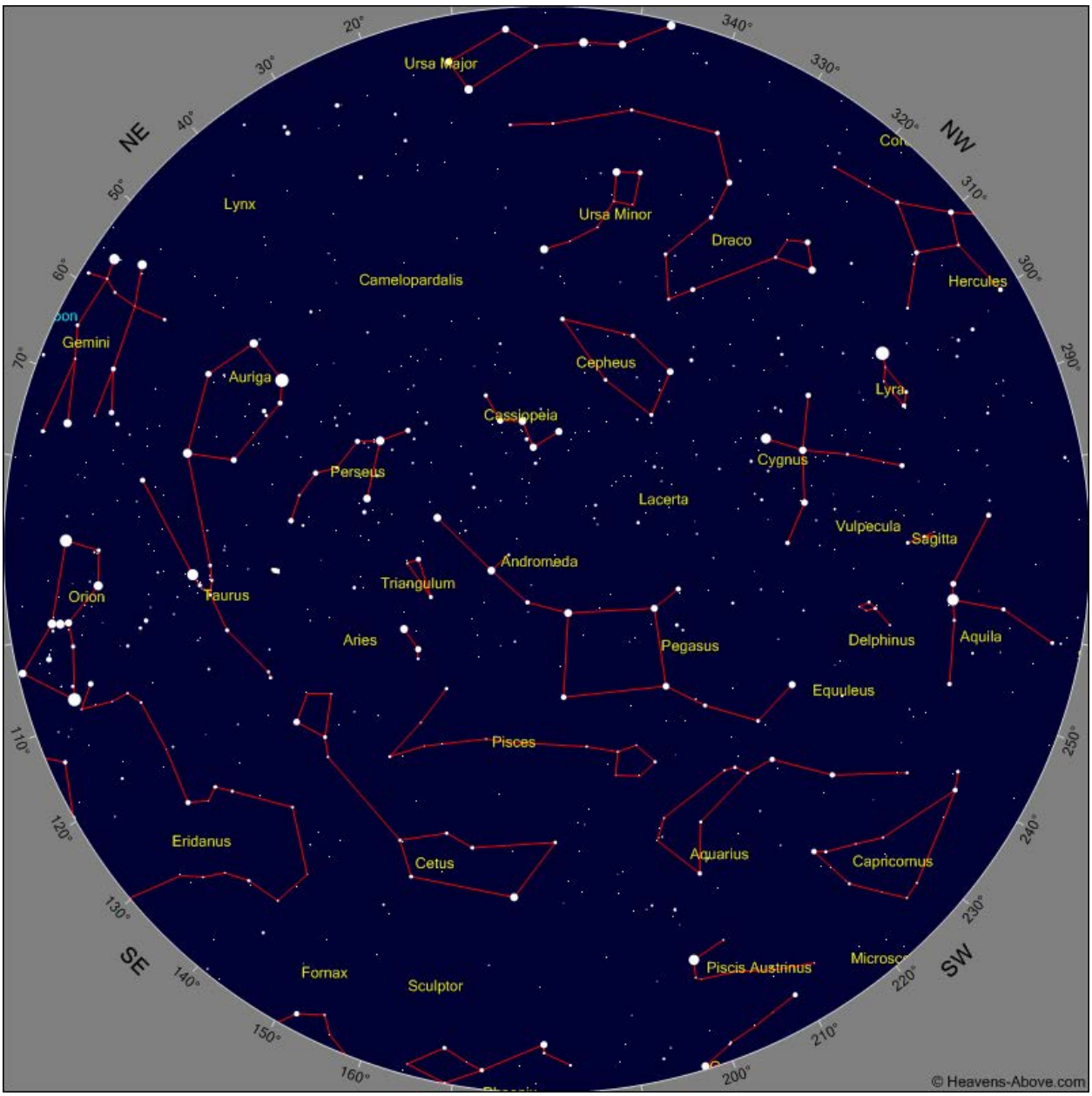

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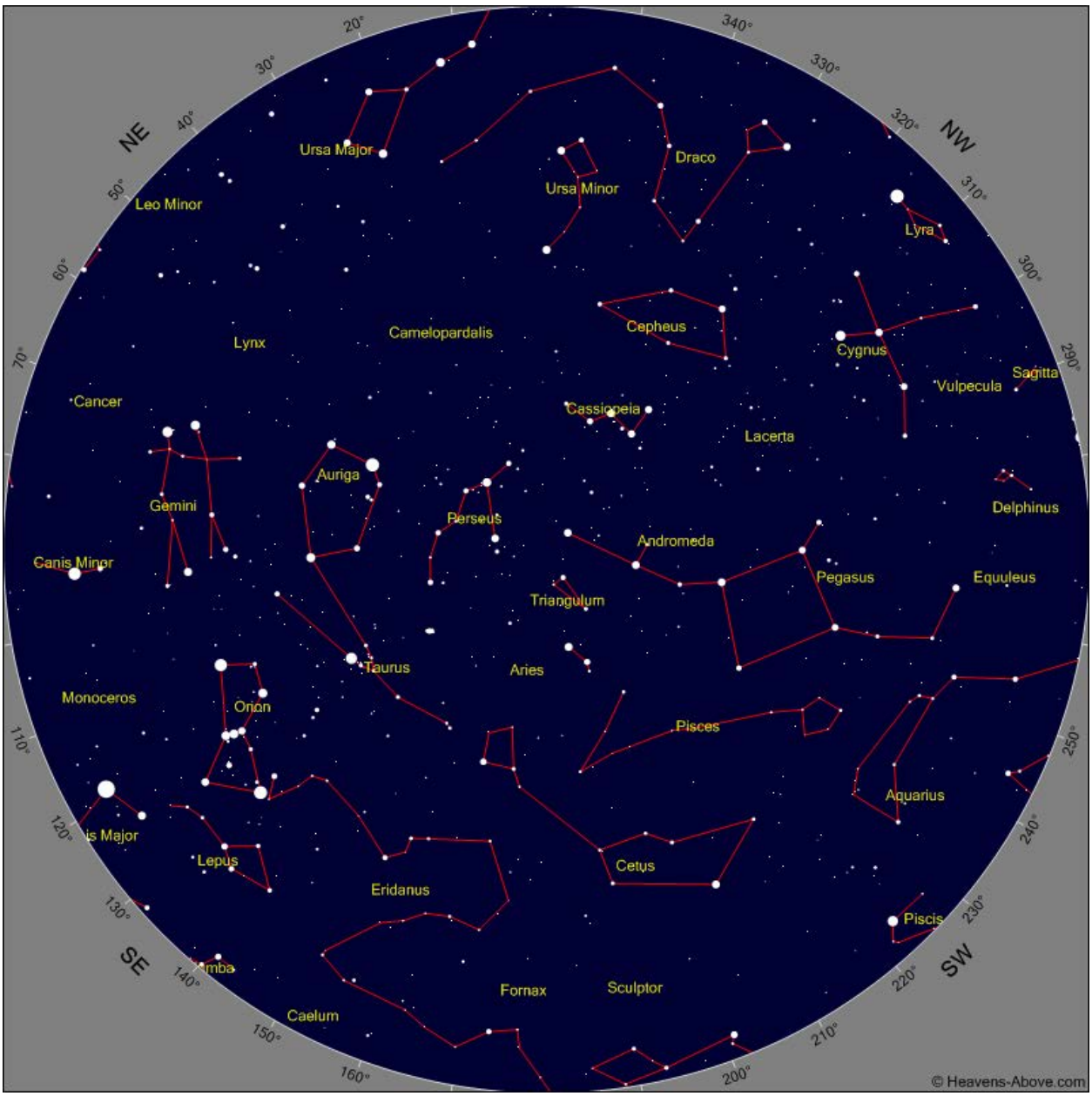

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Edited by Logan Hough
(304) 293-4961
Lhough3@mail.wvu.edu