HON 210 Interstellar Exam II **Name** _____

I. **(10 Pts) Who's Who?**

Match the following names to the descriptions. (Enter the letter.)

A. Penzias	**D.** Pebbles	**G.** Eddington	**J.** Thomson
B. Wheeler	**E.** Slipher	**H.** Hubble	**K.** Kaluza
C. Planck	**F.** Randall	**I.** Rubin	**L.** Michell

a. He confirmed the bending of light in 1919. G

b. Person who originally called black holes dark stars. L

c. She worked on anti-deSitter warping. F

d. She pioneered studies on galaxy rotation rates. I

e. Measured nebulae speeds using Doppler shift. E

f. Coined the term wormhole. B

g. He extended general relativity to five dimensions. K

h. He found that the universe was expanding. H

i. Nobel prize for discoveries in physical cosmology. D

j. A co-discoverer of CMBR. A

II. **(8 pts) Flatland:**

a. Why is it hard to recognize another person in Flatland?

b. How do the shapes reflect social status?

c. How does a Flatlander perceive of a person from Sphereland?

d. How would you perceive a 5 dimensional Bulk Being?

This is due no later than Dec 3rd.

HON 210 Interstellar Exam II **Name** _____

III. **(10 Pts) Terms from the Course**

Find the best match and place the letter in the space provided.

A. Dark Energy	B. Doppler Effect	C. Bulk	D. Dark Matter
E. Lepton	F. Homogeneous	G. Isotropic	H. Spectrograph
I. Brane	J. Vulcan	K. Mercury	L. Quark
M. Cassini	N. Voyager	O. Time Dilation	P. Accretion disk

a. What was probe was forced to crash into Saturn? M

b. A planet hypothesized to exist in the 1800s. J

c. The universe looks the same in any direction. G

d. What is used to detect composition of stars? H

e. What did Zwicky introduce to cosmology? D

f. Region where protons, electrons, and quarks live. I

g. What space probe has left the solar system? N

h. What is the cause of the accelerated expansion of the universe? A

i. La Verrier studied the motion of what planet? K

j. An electron is what fundamental particle in physics? E

IV. **(7 Pts) Numbers**

a. How old is the universe? 14 Gyr or 13.7 Gyr

b. How many galaxies are there? 100 billion

c. What are the current percentages of

i. Dark Energy 68

ii. Cold Dark Matter 27

iii. Radiation $\ll 1$ 9×10^{-5}

d. ~~What is the radius of Gargantua?~~

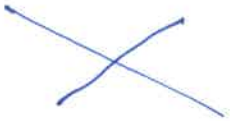
e. How big is a massive black hole? $10^6 - 10^{10} M_\odot$

This is due no later than Dec 3rd.

HON 210 Interstellar Exam II **Name** _____

V. **(16 pts) Short Answers: Be as specific as possible**

a. Describe all of the anomalies in the movie.



b. How do massive black holes form?

Explosions of Massive Stars
Accretion
Big Bang

c. What distinguishes a naked singularity from others?

No event horizon

d. How would you describe the Bulk to a lay person?

e. What was Einstein's greatest blunder?

Cosmological Constant

f. What was Einstein's "happiest thought?"

Equivalence Principle

g. What is a hologram and how is this idea used to describe black holes?

Information is on surface of black hole

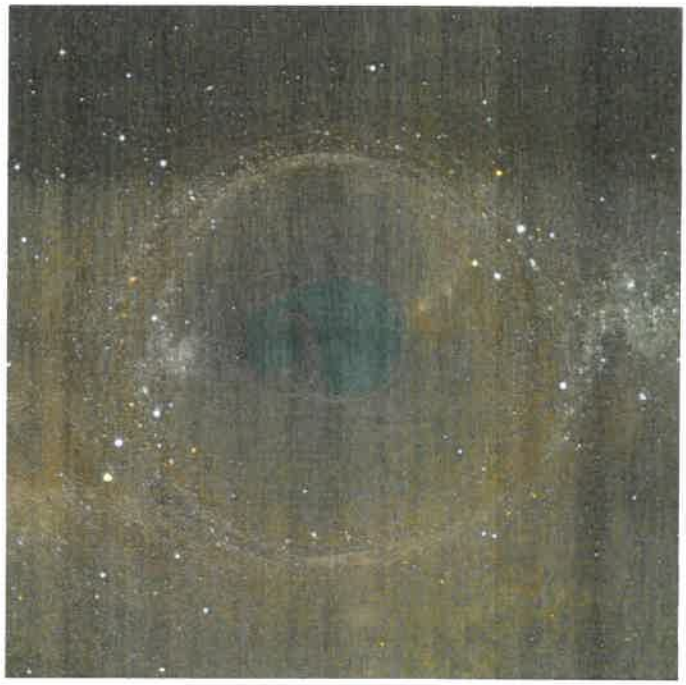
h. You can draw a triangle in Flatland and a 4-pointed pyramid in Sphereland. What would the generalization look like in four dimensions or five dimensions?

This is due no later than Dec 3rd.

HON 210 Interstellar Exam II **Name** _____

VI. **(8 pts) Black Hole Image** Describe what you see in this picture. Make sure to discuss things like Einstein rings, black hole shadows, gravitational lensing, possible multiple images, etc. Describe the physics behind what you see and point out specifics in the image supporting your claims.

Einstein rings
Shadows
Images from gravitational lensing
Rotation
Merger of two black holes



This is due no later than Dec 3rd.

HON 210 Interstellar Exam II **Name** _____

VII. **(6 pts) Science:** Fill in the blanks with the best answer.

a. General relativity is a theory of gravity.

b. What is a WIMP? Weakly interacting massive particles

c. The remnant of radiation from the hot early universe is called the Cosmic microwave background

d. What mission will be the first to place a woman on the Moon? Artemis X

e. A Tesseract is a X.

f. Before 1950's a wormhole was called a Einstein-Rosen bridge.

VIII. **(10 Pts)** Short Essays I. –Write coherent essays on each topic, listing at least five important facts.

a. Dr. Thorne's central vision was to produce a movie where issues in general relativity were central to a compelling story, and were communicated accurately. Where was this most successful? Least successful?

b. What scientific, mathematical, and humanitarian questions did the movie raise?

This is due no later than Dec 3rd.