HON 210 Physics of Interstellar Review for Exam II Last Update November 19, 2020

I. General Topics
   A. The Movie
      1. Know the characters
      2. Know the events
      3. Know the planets, Gargantua, wormhole
      4. Dust Bowl and Blight and Other Disasters
   B. The Science
      1. Gargantua - features
      2. Wormhole
      3. Visualization

II. Physics
   A. Classical Physics
      1. Newton's physics
         a. Gravitation
         b. Escape Velocity
         c. Halley's Comet
         d. Gravitational Slingshot
      2. Electromagnetism
         a. Electromagnetic waves
         b. Visible Light and other relevant wavelengths
         c. Doppler Effect
         d. Spectral Lines
      3. Optics
         a. Reflection, Refraction, Snell's Law, Apparent Depth of objects
      4. Thermal physics
   B. Relativity
      1. Time Dilation
      2. Gravitational Redshift
      3. Spacetime
      4. General vs Special
      5. Tidal Gravity, Ocean Tides
      6. GPS
      7. Gravitational Lensing, Einstein Ring, Multiple images
      8. Time-like geodesics and null geodesics
      9. Embedding Diagram
   C. Astronomy
      1. The Universe
         a. Size, age, number of objects
         b. Major galaxies
         c. Milky Way
         d. Solar system
      2. Telescopes - Optical, Radio, Hubble, Webb
      3. Stellar evolution
         a. White dwarfs, neutron stars, black holes, IMBHs

4. Space Exploration
    a. Sputnik, Mercury, Gemini, Apollo, Artemis
    b. Voyager, Pioneer, Mariner, Cassini, New Horizons
    c. Space Stations, Mars Rovers
5. Interstellar Travel

D. Black Holes
1. History
2. Quasars, Jets
3. Shadow
4. Accretion disks
5. Event Horizon
6. Spinning vs non-spinning
7. Space Dragging
8. Shell of Fire

III. People
A. Isaac Newton
B. James Clerk Maxwell
C. Albert Einstein
D. Karl Schwarzschild
E. Roy Kerr
F. Max Planck
G. Niels Bohr
H. Marie and Pierre Curie
I. Sir Arthur Eddington
J. Robert J. Oppenheimer
K. Chandrasekhar
L. Edwin Hubble
M. John Wheeler
N. Richard Feynman
O. Donald Lynden-Bell
P. Stephen Hawking
Q. Kip Thorne
R. Chris Nolan
S. Jonah Nolan
T. Paul Franklin
U. Professor Brand, Cooper, et al.
V. Edmunds, Miller, Mann
W. Endurance, Ranger

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Since Exam I

IV. Wormholes
- A. 1916 Flamm
- B. 1935 Einstein-Rosen bridge
- C. 1st diagram Wheeler
- D. Morris, Thorne Yurtsever – traversable wormholes
- E. Carl Sagan's *Contact*
- F. Collapse
- G. Appearance – throat, mouth, appearance in Interstellar

V. Gargantua's vibrations

VI. Mann's Planet
- A. Geology
- B. Orbiting and Escaping

VII. Endurance construction

VIII. Higher Dimensions
- A. 4th and 5th dimensions
- B. Superstrings, branes, the bulk, number of dimensions
- C. Analogy with *Flatland*
- D. Confining gravity in the bulk, AdS Sandwich

IX. Gravitational Anomalies
- A. Precession of Mercury – LeVerrier, Vulcan
- B. Dark Matter – rotation curves, gravitational lensing, Zwicky, Vera Rubin, dark halo
- C. Dark Energy – Accelerated expansion of the universe – CMB, COBE, WMAP, BOOMERanG
- D. *Interstellar*'s anomalies
- E. CMB, Penzias and Wilson, Princeton group – Dicke, Peebles, Wilkinson. Challenged Hoyle's steady state.
- F. Standard Cosmological model – percentages of dark energy/matter vs normal matter/energy.
- G. Standard Model of Particle Physics
  1. Fundamental particles, quark, lepton, boson, fermion
  2. Fundamental forces (strong, weak, electromagnetic gravitational)
- H. String Theory, Kaluza-Klein, Calabi Yau,
- I. AdS/CFT,
- J. Holographic principle

X. Professor's equation

XI. Singularities
- A. Inside the event horizon.
- B. Different types.

XII. The Tesseract and making time a physical dimension.

XIII. Time travel.