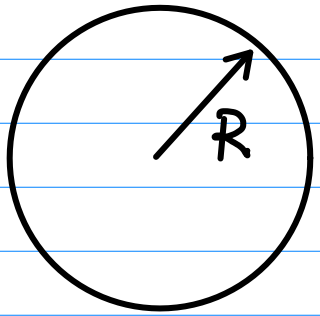
IF THE MASS OF THE COLLAPSED CORE IS $> 3M_{\odot}$ THE DEGENERACY PRESSURE OF NEUTRONS CANNOT SUPPORT IT AND IT COLLAPSES INTO A SINGLE POINT — A SINGULARITY IN SPACETIME. THE RESULTING OBJECT IS CALLED BLACK HOLE.

RECALL THE CONCEPT OF ESCAPE VELOCITY ($v_{esc.}$) FROM A BODY OF MASS M AND RADIUS R:



MASS M

GRAVITATIONAL CONSTANT

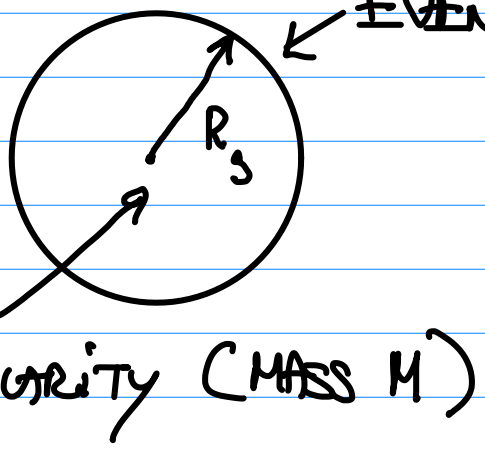
$$v_{esc}^2 = \frac{GM}{R}$$

(RESULT OBTAINED WITH NEWTONIAN GRAVITY)

FOR GIVEN MASS (M) AS THE RADIUS (R) IS REDUCED v_{esc} INCREASES AND COULD

BECOME GREATER THAN THE SPEED OF LIGHT c ($= 300{,}000$ km/s). THEN NOTHING, INCLUDING LIGHT, CAN ESCAPE THE GRAVITY OF THE BODY. HENCE THE NAME BLACK HOLE.

SCHWARZSCHILD RADIUS R_S: IT IS A DISTANCE FROM THE BODY WITHIN WHICH THE ESCAPE VELOCITY IS GREATER THAN THE SPEED OF LIGHT:

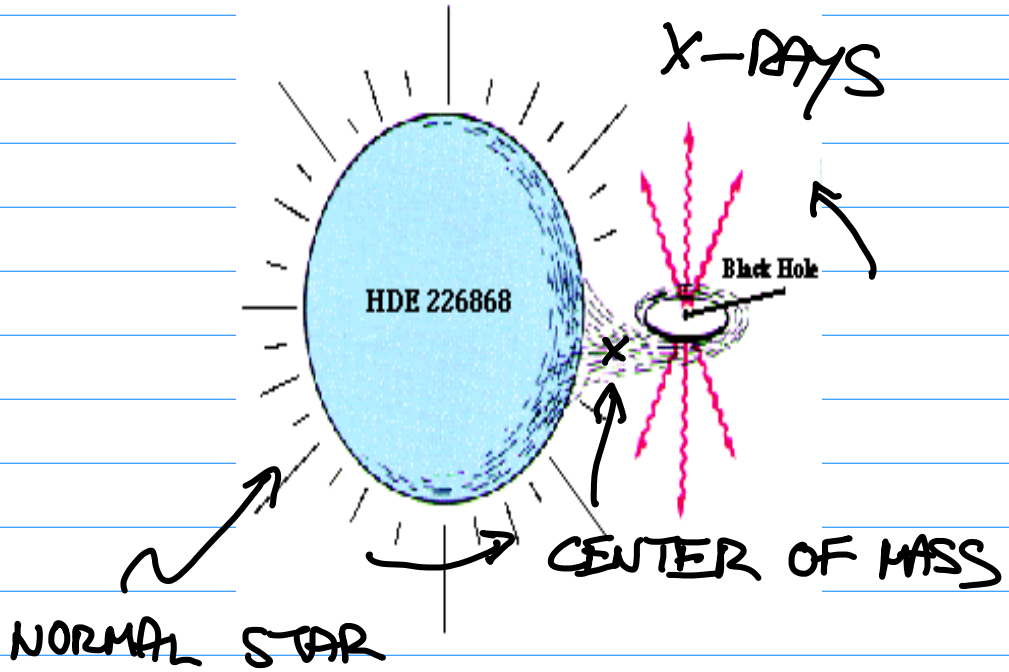


$$R_S = 3M$$

in km, in $M_\odot$

THUS FOR $M = 10 M_\odot$ $R_S = 30$ km.

WHAT IS THE OBSERVATIONAL EVIDENCE FOR BLACK HOLES?

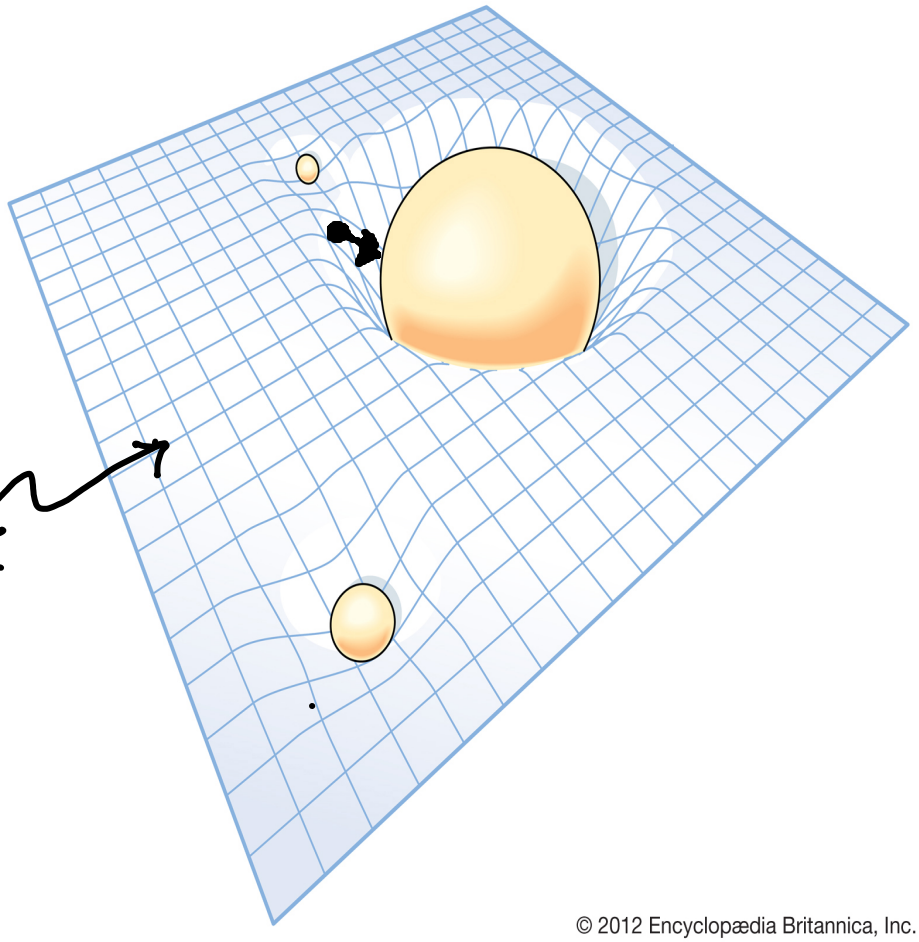


ONE LOOKS FOR A BINARY SYSTEM OF NORMAL STAR AND AN INVISIBLE COMPANION WITH A MASS OF AT LEAST $3M_\odot$ WHICH IS A STRONG SOURCE OF X-RAYS (PRODUCED BY ACCELERATION OF STELLAR WIND PARTICLES AS A RESULT OF A STRONG GRAVITATIONAL PULL BY THE BLACK HOLE).

THE FIRST OBSERVATION WAS MADE BY TOM BOLTON IN 1971 USING 1.9m REFLECTOR TELESCOPE AT THE DAVID DUNLAP OBSERVATORY IN RICHMOND HILL.

THE NORMAL STAR WAS CYGNUS AND THE BLACK HOLE WAS NAMED CYGNUS X1. $M_{STAR} = 27 M_{\odot}$ AND $M_{BLACK\ HOLE} = 15 M_{\odot}$.

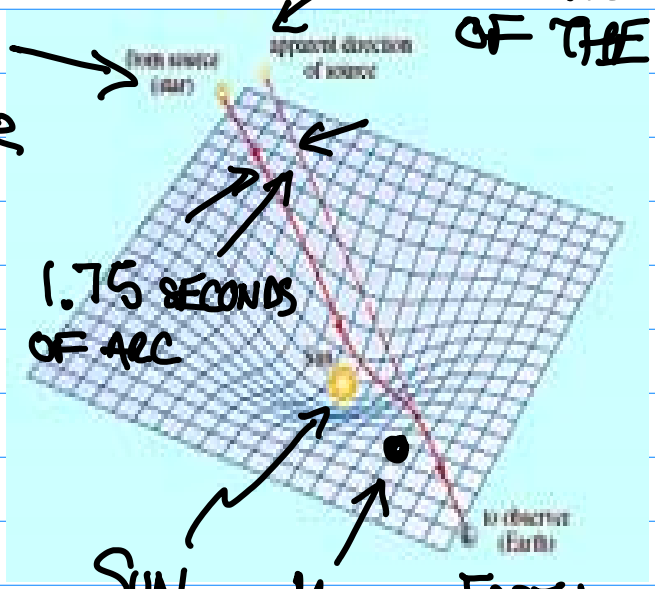
TO DESCRIBE VICINITY OF BLACK HOLES (NEUTRON STARS, WHITE DWARFS, AND STARS [E.G. SUN]) ONE NEEDS EINSTEIN'S GENERAL THEORY OF RELATIVITY (1915): MASS OR ENERGY BENDS SPACE AND OTHER OBJECTS MOVE IN THAT SPACE ALONG THE PATHS OF SHORTEST DISTANCE (GEODESICS).



THE SUN ($M = 10^{30}$ kg = 300,000 TIMES THE MASS OF THE EARTH) BENDS THE STARLIGHT

ACTUAL POSITION OF A STAR

THE APPARENT POSITION OF THE SAME STAR



TOTAL SOLAR ECLIPSE