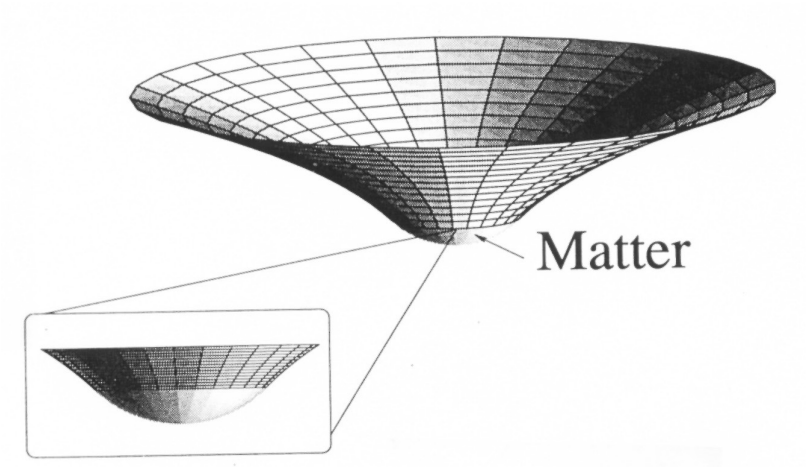
Gravitational Potential For Stars larger than the Black Hole Limit

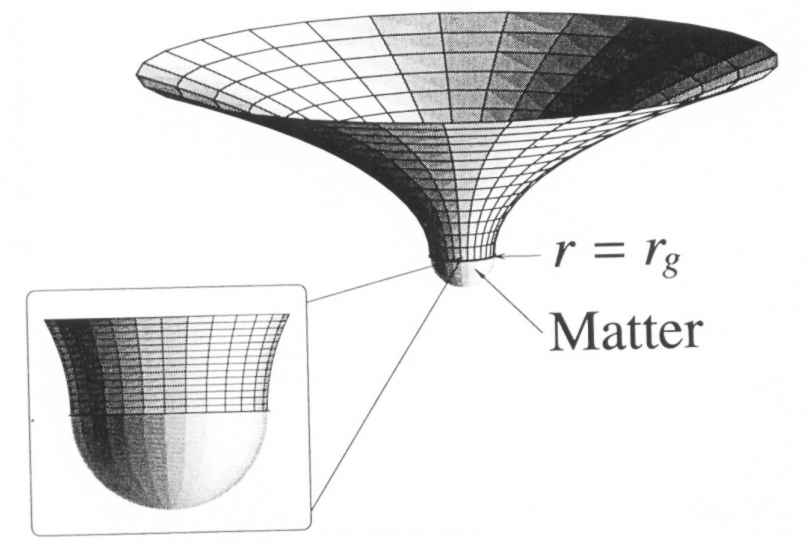
The gravitational membrane associated with a star does not come to a point. The point can be present only in Newtonian gravity and only if the mass is concentrated into a point as well. When the mass is in a star, the potential at any radius depends on the amount of mass interior to that radius. As long as the point is outside the star, the total mass of the star is interior to the radius. However, as soon as the point is inside the star, some of the star mass will be outside point and will not count as mass interior to the point. Consequently, the mass interior to the point decreases as the point moves inward and the downward distortion of the gravitational membrane is less steep. At the center of the star, there is no more mass interior so the membrane has a rounded innermost point. This structure is shown below:



As long as the star is small compared to the critical Roche surface, the shape shown above applies as well to stars inside binary systems, at least for the more compact stars.

Gravitational Potential for the Limiting Mass and for Black Holes

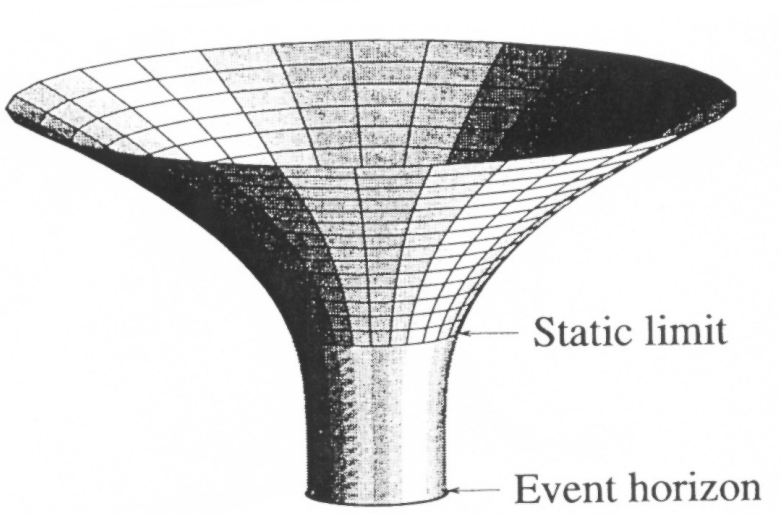
The picture of a normal star holds until the radius of the star approaches the limiting case for the formation of a black hole. This radius is called the Schwarzschild Radius which is usually associated with the formation of a black hole. Near this radius, the fabric of space-time can no longer be constructed in a stationary state. All locally acceptable laboratory frames (formally called an inertial reference frame) must collapse inward toward the black hole center. For this case the basic fabric of space-time is altered fundamentally. At the Schwarzschild Radius, the star becomes an official black hole. The local slope of gravitational energy relative to position becomes infinite and nothing can escape. The structure of the gravitational field membrane at the critical radius where the black hole forms is shown below:



The critical point identified with the black hole formation is shown as r_g. This case has the photon emitted from r_g just able to reach infinite distance. The points inside near the center of the star are well bound and cannot reach infinite distance from the black hole before falling back.

The gravitational potential of a black hole which definitively over the limit.

For a star which is definitely a black hole, the rounded bottom of the gravitational potential can have no effect on the matter outside. This result is sometimes stated as the theorm: Black Holes have no hair which means that all features or unique properties which might otherwise be used to identify it from other black holes are lost except for the mass, rotational angular momentum and electrical charge. For this case we can neglect all properties of the matter which has already been encorporated into the black hole since they cannot come out and be examined. Below is the gravitational membrane which results when a potentially infected person is allowed to stay in contact with other people.

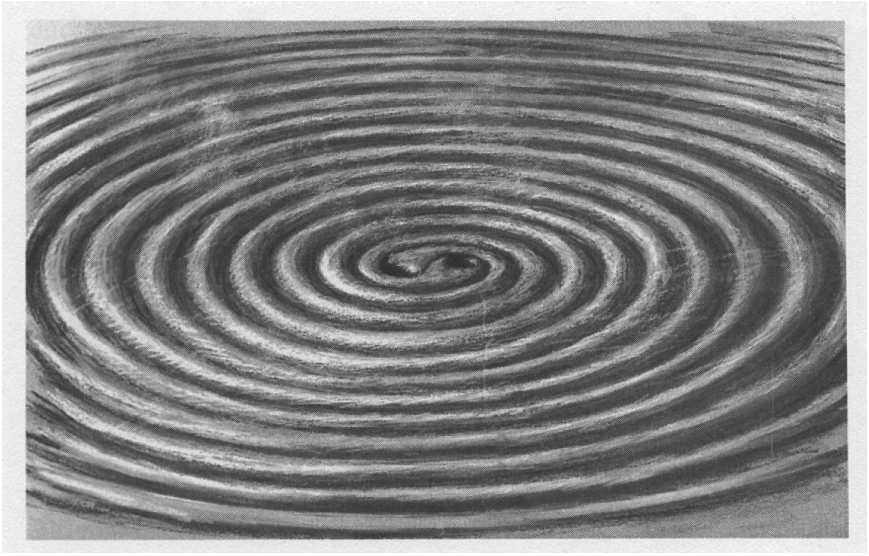


This figure shows the shape of the gravitational attraction sheet when the underlying star has reached a radius less than the critical radius. In this case, there is no fabric of space near the star center. The space-time fabric interior to the static point is always in a state of collapsing.

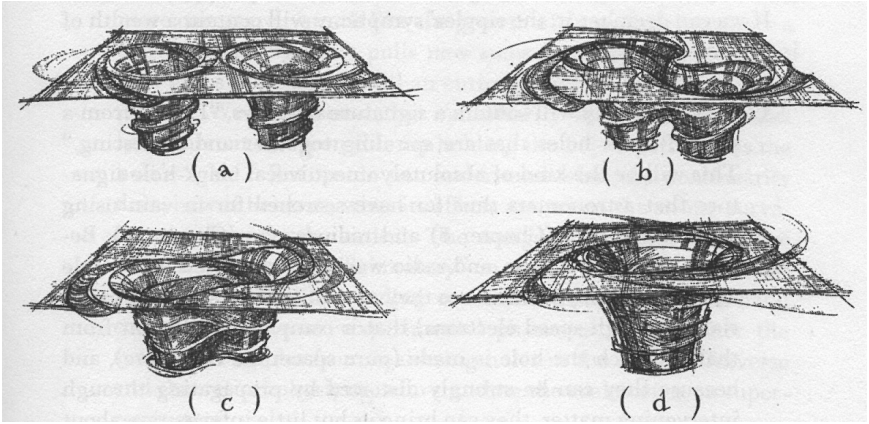
Black Hole Processes

Pairs of black holes and pairs of neutron stars can interact in two ways:

1. Two black holes, two neutron stars or a black hole and a neutron star in orbit generate gravity waves:

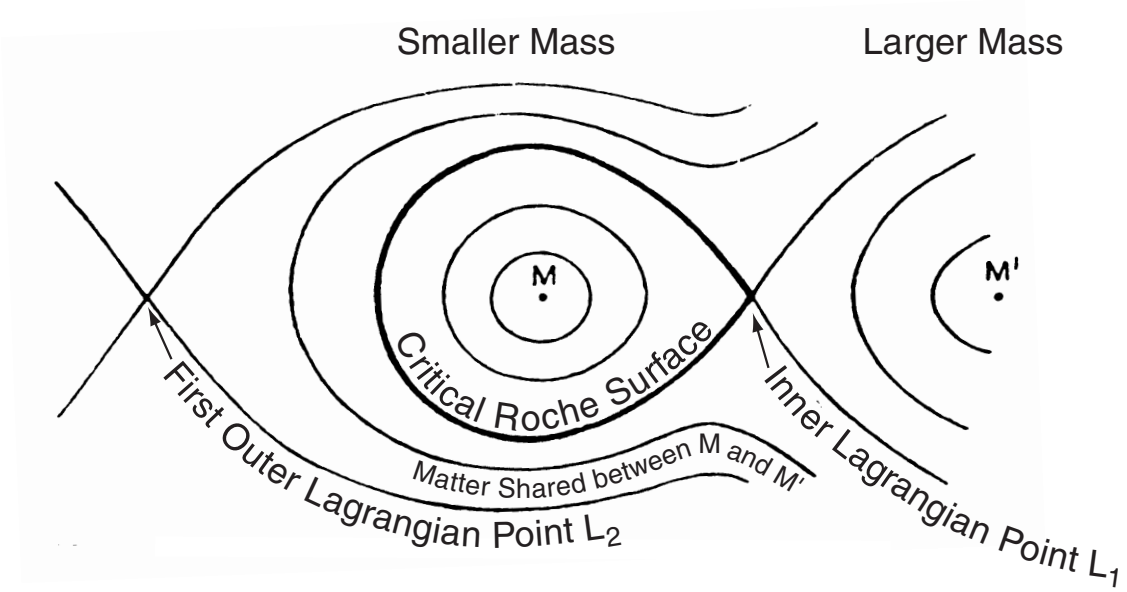


2. Two spinning black holes can merge when the are close enough together. The merged black hole combines the properties of the two separate black holes.



Gravitation in a Binary System

In a rotating binary system, the gravitational energy is modified to include the centrifugal force which comes from the fact that the coordinates stationary relative to the two stars is not moving in a straight line. The energy is represented as if it were in a contour map giving the elevations of geographic features. With the gravitational holes provided by the two stars, there is a pair of deep depressions in the gravitational membrane corresponding to the effects of the two mass concentrations. At larger distances from the stars, the rotation produces a distorsion of the contour lines as a result of the same type of force combination which produces tides on the Earth: points which are closer than average to the other star are attracted more strongly than points further away. The effect is to apply an apparent force which tends to stretch the star into a football shaped star. The contour lines are shown below for the part of space nearest the less massive star of the system:



This figure shows the lines of equal gravitational potential energy near a binary system where the partially shown star on the right has a higer mass than the star on the left. The less massive star can nonetheless be in the process of overflowing its inner Roche surface and transferring mass to the already more massive star. The heavy line corresponds to the energy where a grain of matter can either fall onto the more massive or onto the less massive star.