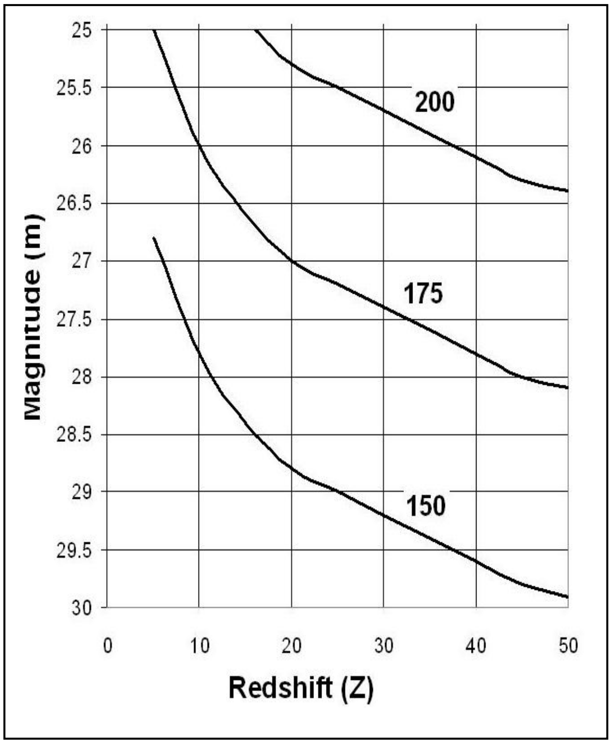

When the Webb Space Telescope begins operation in ca 2015, one of its first scientific goals will be to detect, if they exist, the most distant supernova in the universe.

Astronomers predict that soon after the Big Bang, stars more massive than our own sun were commonly formed - but exploded as supernova within a few million years after birth. This is a crucial phase in the evolution of our universe. Without them, the elements that now form planets and living systems would not exist.

These supernovae, surrounded by dense clouds of dust, will be very faint, and can only be observed at infrared wavelengths, and with very large telescopes like the Webb Space Telescope.

The graph to the left shows the predicted brightness of these massive 'Population III' supernovae for stars with different masses: 200 (top), 175 (middle) and 150 (bottom) times the mass of our sun.

The vertical scale is in terms of the stellar magnitude scale, which indicates the logarithmic brightness of a star. On this scale, our sun has a brightness of about -26.0. The faintest star visible with the human eye is about +6.0. Each magnitude step represents a factor of 2.512 in brightness change so that 5 magnitudes of change is exactly a factor of 100.0.

The horizontal scale gives the distance to the supernova in terms of its cosmological redshift. On this scale, the distance to the nearest galaxy, Andromeda, is about z = 0.001 and the most distant known quasar is at about z = 3.0. It is expected that infant stars will be detected by their light at a distance of z between 20 - 50, which corresponds to a time about 100 million years after the Big Bang. At a distance of z > 1000 the universe was opaque to starlight when the universe was less than 300,000 years old.

Problem 1 - For a 10,000-second exposure, the NIR Camera on the Webb Space Telescope can detect objects brighter than a magnitude of +29.0. Out to what redshift will the NIR camera be able to see supernova from stars about 150 times the mass of our sun?

Problem 2 - At a redshift of z = 30, by what factor is the supernova of a star with a mass of 200 times the sun, brighter than the supernova of a star with a mass of 150 times the sun?

Problem 1 - For a 10,000-second exposure, the NIR Camera on the Webb Space Telescope can detect objects brighter than a magnitude of +29.0. Out to what redshift will it be able to see supernova from stars about 150 times the mass of our sun?
Answer: See graph below: **z = 25** is where the limit curve of m = +29.0 intersects the predicted supernova magnitude curve at this mass.

Problem 2 - At a redshift of z = 30, by what factor is the supernova of a star with a mass of 200 times the sun, brighter than the supernova of a star with a mass of 150 times the sun?

Answer: According to the graph below, at a redshift of Z = 30, the curve for a 150 solar mass star has a value of m = +29.2, and for a 200 solar mass star at the same Z we have m = +25.7. The difference in brightness is 29.2 - 25.7 = + 3.5. The brightness factor is between
(2.512)(2.512)(2.512) = 16 times and
(2.512)(2.512)(2.512)(2.512) = 40 times. (The actual factor, is 25 times)

At this redshift, the supernova from a 200 solar mass star is between 16 and 40 times brighter than the supernova from a 150 solar mass star.