A Pulsar Shot Out from a Supernova Explosion!

The Chandra X-ray Observatory has seen a fast-moving pulsar escaping from a supernova remnant while spewing out a record-breaking jet. This is, to date, the longest object observed in the Milky Way galaxy. The jet is nearly 37 light years long! The pulsar is 60 light years from the supernova remnant.

The supernova remnant, called SNR MSH 11-61A, is in the constellation of Carina, and located 23,000 light years from Earth.

Problem 1 – If one light year equals 9.5×10^{12} kilometers, how far is the pulsar from the supernova remnant?

Problem 2 – How long is the jet in kilometers?

Problem 3 – The supernova is estimated to have exploded about 9,000 years ago. How fast has the pulsar been traveling to get to its current location? Calculate this speed in a) km/sec and b) miles/hour.

Problem 4 – Our sun has a diameter of 1.4 million kilometers. The pulsar has a diameter of only 20 km, but carries twice the mass of our sun. Explain what would happen if the pulsar collided with a star like our sun.

NASA's Chandra Sees Runaway Pulsar Firing an Extraordinary Jet
February 18, 2014
http://www.nasa.gov/press/2014/february/nasas-chandra-sees-runaway-pulsar-firing-an-extraordinary-jet/index.html

Problem 1 – If one light year equals 9.5×10^{12} kilometers, how far is the pulsar from the supernova remnant?

Answer: $60 \times 9.5 \times 10^{12}$ km = **5.7×10^{14} km**.

Problem 2 – How long is the jet in kilometers?

Answer: $37 \times 9.5 \times 10^{12}$ km = **3.5×10^{14} km**.

Problem 3 – The supernova is estimated to have exploded about 9,000 years ago. How fast has the pulsar been traveling to get to its current location? Calculate this speed in a) km/sec and b) miles/hour.

Answer: 1 year = 3.1×10^{7} seconds. Based upon this, the travel time is 9,000 yrs. x 3.1×10^{7} sec/year = 2.8×10^{11} seconds.

A) From Problem 1, the distance is 5.7×10^{14} km, therefore the average speed is 5.7×10^{14} km/2.8×10^{11} sec = **2000 km/sec**.

B) 1 km = 0.62 miles
2000 km/sec x (0.62 miles/1 km) x (3600 sec/1hr) = **4.5 million miles/hour.**

Problem 4 – Our sun has a diameter of 1.4 million kilometers. The pulsar has a diameter of only 20 km, but carries twice the mass of our sun. Explain what would happen if the pulsar collided with a star like our sun.

Answer: Traveling at 2000 km/sec, it would take the pulsar 12 minutes to travel through a star like our sun (1.4 million/2000 km/sec = 700 seconds or 12 minutes). Because the density of the pulsar is over one trillion times that of our sun, it would be like a bullet traveling through a cloud in the sky!

At a great distance, the sun would respond to the gravity of the pulsar and start to deform like a football with the long axis pointed close to the direction of the pulsar. The time it takes the pulsar to travel from Earth's orbit to the sun is only 150 million km/2000 km/sec = 21 hours. An object as huge as the sun would not have much time to deform before the encounter was over. The pulsar would shoot through the interior of the sun and exit the other side before our sun had much of a chance to change its shape. The friction of the pulsar against the gases in the sun would probably increase the temperature along the path by a few thousand degrees. This would not have much effect on the sun that has interior temperatures between 100,000 to 15 million degrees ^{o}C.