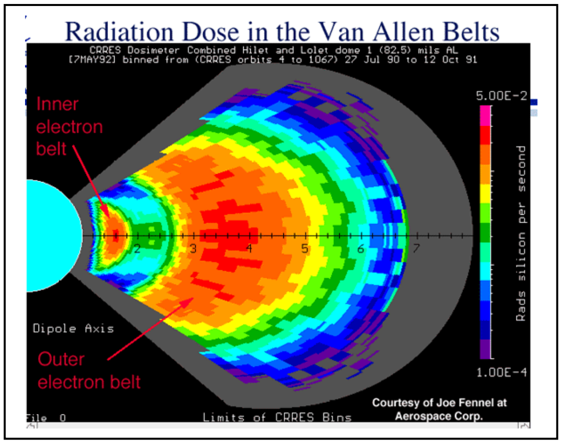

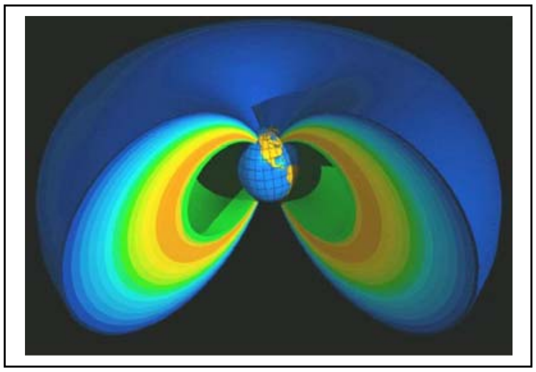

Most artistic illustrations of the Van Allen belts make them look almost solid, and the colors chosen make them look especially brilliant in vibrant crimsons and blues. These colors are symbolic and are chosen to represent information about the belts rather than what they actually look like. In fact, if you were standing in the middle of the belts you would not even see them at all!

The Van Allen belts contain trillions of high energy particles that over time can be lethal to an exposed astronaut. They can also damage satellites and spacecraft. But there are very few of these particles in any cubic meter of space. The particles are very small and amount to very little mass at all when added together.

The volume occupied by the Van Allen belts forms a donut-shaped region called a torus, which extends from about 10,000 km to 42,000 km from Earth and equals about 1.3×10^{23} meters^3**.** To find the total mass of the Van Allen belts we use the basic principle that mass = density x volume.

Problem 1 – The average density of electrons and protons in the Van Allen belts is about 100 particles per meter^3. There are about equal numbers of electrons and protons. The protons have a mass of 1.7×10^{-27} kg and electrons have a mass of about 9.1×10^{-31} kg. What are the densities of the electrons and protons in kg/m^3?

Problem 2 – Based on the estimated volume of the Van Allen belts, what is the total mass in A) electrons? B) protons C) combined mass in grams?

Problem 3 – A typical donut has a mass of 33 grams. What is the mass of the Van Allen belts in donuts?

Problem 1 – The average density of electrons and protons in the Van Allen belts is about 100 particles per meter^3. There are about equal numbers of electrons and protons. The protons have a mass of 1.7 x 10^{-27} kg and electrons have a mass of about 9.1 x 10^{-31} kg. What are the densities of the electrons and protons in kg/m^3?

Answer: Density = 50 electrons/m^3 x (9.1 x 10^{-31} kg/electron) = 4.6 x 10^{-29} kg/m^3
Density = 50 protons/m^3 x (1.7 x 10^{-27} kg/electron) = 8.5 x 10^{-26} kg/m^3

Problem 2 – Based on the estimated volume of the Van Allen belts, what is the total mass in A) electrons? B) protons C) combined mass in grams?

A) M(electrons) = density x volume
= (4.6 x 10^{-29} kg/m^3) (1.3 x 10^{23} meters^3) = 6.0 x 10^{-6} kilograms
B) M(Protons) = density x volume
= (8.5 x 10^{-26} kg/m^3) (1.3 x 10^{23} meters^3) = 1.1 x 10^{-2} kilograms

C) Combined = 0.011 kg x (1000 grams/1kg) = **11 grams!**

Problem 3 – A typical donut has a mass of 33 grams. What is the mass of the Van Allen belts in donuts?

Answer: Our 'donut-shaped' Van Allen belts have **1/3 the mass** of an actual donut!!!