What happened to Mars? A planetary mystery

November 13 2013, by Dr. Tony Phillips

NASA's MAVEN (Mars Atmosphere and Volatile EvolutioN) spacecraft, inside a payload fairing, is hoisted to the top of a United Launch Alliance Atlas V rocket at the Vertical Integration Facility at Cape Canaveral Air Force Station's Space Launch Complex 41. The move and hoisting operations mark another major milestone for the launch team as everything proceeds on schedule to launch Nov. 18, when the Atlas V will lift MAVEN into space and on to Mars.

The two-hour launch window extends from 1:28 to 3:28 p.m. EST. MAVEN is the first spacecraft devoted to exploring and understanding the Martian upper atmosphere. It will orbit the planet in an elliptical orbit that allows it to pass through and sample the entire upper atmosphere on every orbit. The spacecraft will investigate how the loss of Mars' atmosphere to space determined the history of water on the surface. Credit: NASA

Billions of years ago when the planets of our solar system were still young, Mars was a very different world. Liquid water flowed in long rivers that emptied into lakes and shallow seas. A thick atmosphere blanketed the planet and kept it warm. In this cozy environment, living microbes might have found a home, starting Mars down the path toward becoming a second life-filled planet next door to our own.

But that's not how things turned out.

Today, Mars is bitter cold and desiccated. The planet's thin, wispy atmosphere provides scant cover for a surface marked by dry riverbeds and empty lakes. If Martian microbes still exist, they're probably eking out a meager existence somewhere beneath the dusty Martian soil.

What happened? This haunting question has long puzzled scientists. To find the answer, NASA is sending a new orbiter to Mars called MAVEN (Mars Atmosphere and Volatile Evolution).

"The goal of MAVEN is to figure out what processes were responsible for those changes in Martian climate," says Bruce Jakosky, Principal Investigator for MAVEN at the University of Colorado at Boulder.

Scheduled for launch in Nov. 2013, and due to arrive in Sept. 2014, MAVEN is bristling with instruments to study Mars' upper atmosphere.

That's where many researchers believe the answer lies.

The only way Mars could have been wet and warm 4 billion years ago, is if it also had a thick atmosphere. CO2 in the Martian atmosphere is a greenhouse gas, just as it is in our own atmosphere. A thick blanket of CO2 and other greenhouse gases would have provided the warmer temperatures and greater atmospheric pressure required to keep liquid water from freezing solid or boiling away.

Something caused Mars to lose that blanket. One possibility is the solar wind. Unlike Earth, Mars is not protected by a global magnetic field. Instead, it has "magnetic umbrellas" scattered around the planet that shelter only part of the atmosphere. Erosion of exposed areas by solar wind might have slowly stripped the atmosphere away over billions of years. Recent measurements of isotopes in the Martian atmosphere by Mars rover Curiosity support this idea: light isotopes of hydrogen and argon are depleted compared to their heavier counterparts, suggesting that they have floated away into space.

Scientists have also speculated that the planet's surface might have absorbed the CO2 and locked it up in minerals such as carbonate. However, this theory has faded in recent years as Mars rovers and orbiters have failed to find enough carbonate to account for the missing gas.

MAVEN will be the first mission to Mars specifically designed to help scientists understand the ongoing escape of CO2 and other gases into space. The probe will orbit Mars for at least one Earth-year. At the elliptical orbit's low point, MAVEN will be 125 km above the surface; its high point will take it more than 6000 km out into space. MAVEN's instruments will track ions and molecules in this broad cross-section of the Martian atmosphere, thoroughly documenting the flow of CO2 and other molecules into space for the first time.

Once Jakosky and his colleagues know how quickly Mars is losing CO2 right now, they can extrapolate backward in time to estimate the total amount lost during the last four billion years. "MAVEN will determine if loss to space was the most important player in driving Martian climate change," Jakosky says.

In the grand scheme of the Solar System, Earth orbits alongside a world that began with as much promise for life as our own … yet turned out so differently. After all these years, MAVEN could write the final chapter in a haunting planetary mystery.

Provided by NASA