Earth-like planets may be more common than once thought

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Artist's impression the surface of an ocean-covered planet in the habitable zone of a system with a "hot Jupiter." A "hot Earth" and the hot Jupiter are seen close to the setting sun. Massive waves and storms wash over the planet, a possible result of a lack of continents. Credit: Nahks Tr'Enhl 2006

More than one-third of the giant planet systems recently detected outside Earth's solar system may harbor Earth-like planets, many covered in deep oceans with potential for life, according to a new study led by the University of Colorado at Boulder and Pennsylvania State University.

The study focuses on a type of planetary system unlike our solar system that contains gas giants known as "Hot Jupiters" orbiting extremely close to their parent stars -- even closer than Mercury to our sun, said CU-

Boulder researcher Sean Raymond. Such gas giants are believed to have migrated inward toward their parent stars as the planetary systems were forming, disrupting the space environment and triggering the formation of ocean-covered, Earth-like planets in a "habitable zone" conducive to the evolution of life, according to the new study.

"Exotic Earths: Forming Habitable Worlds with Giant Planet Migration" was published in the Sept. 8 issue of *Science* and authored by Raymond, Avi Mandell of both Penn State and Goddard Space Flight Center in Greenbelt, Md., and Steinn Sigurdsonn of NASA's Goddard Center.

The study indicates Hot Jupiters push and pull proto-planetary disk material during their journeys, flinging rocky debris outward where it is likely to coalesce into Earth-like planets, said Raymond. At the same time, turbulent forces from the dense surrounding gas slow down the orbits of small, icy bodies in the outer reaches of the disk, causing them to spiral inward and deliver water to the fledgling planets. Such planets may eventually host oceans several miles deep, according to the study.

Schematic view (not to scale) of a habitable planetary system with a "hot Jupiter", compared with our solar system (upper planets). The Solar system has four terrestrial planets: Mercury, Venus, Earth and Mars. Earth is in the habitable zone, where water can exist on its surface. The other planetary system contains a "hot Earth" a few times larger than the Earth but very close to the star,

an ocean-covered planet in the habitable zone, and several icy planets in the outer system. Credit: Sean Raymond, CU-Boulder, using images from NASA

"These gas giants cause quite a ruckus," said Raymond of CU-Boulder's Laboratory for Atmospheric and Space Physics. "We now think there is a new class of ocean-covered, and possibly habitable, planets in solar systems unlike our own."

Scientists had previously assumed that as Hot Jupiters plowed through proto-planetary material on their inward migrations toward parent stars, all the surrounding material would be "vacuumed up" or ejected from the system, he said. "The new models indicate these early ideas were probably wrong," said Raymond.

The research team ran exhaustive simulations lasting more than eight months each on more than a dozen desktop computers, starting with proto-planetary disks containing more than 1,000 moon-sized, rocky and icy bodies. The initial conditions for each computer model were based on current theories of how planets form in our own solar system and simulated about 200 million years of planetary evolution.

The team concluded that about one of every three known planetary systems could have evolved as-yet-undetected Earth-like planets in so-called habitable zones like the one Earth is in, he said. A whopping 40 percent of the 200 or so known planets around other stars are Hot Jupiters, although the percentage probably will decrease as more distant planets are discovered, said Raymond.

In addition to Earth-like planets that form in habitable zones outside Hot Jupiters, the simulations showed some rocky planets known as "Hot Earths" often form inside the orbits of Hot Jupiters, said Raymond. A

Hot Earth, with a radius twice that of our own Earth, was discovered in 2005 in a nearby star system orbiting just 2 million miles from its parent star by a team led by University of California, Berkeley, planetary scientist Geoffrey Marcy.

The new simulations showed both Hot Earths and Earth-like planets in habitable zones formed with large amounts of water, up to 100 times the water present on Earth today, he said. The models indicate such water-rich planets would probably contain a lower percentage of iron - which may be important for the evolution and possible oxygenation of evolving atmospheres - than Earth, he said.

According to the team's simulations, Hot Earths can form astoundingly fast, in just 100,000 years or so. Earth-like planets in habitable zones form much more slowly, taking up to 200 million years, said Raymond. Geologists believe Earth took about 30 million years to 50 million years to fully form.

"I think there are definitely habitable planets out there," said Raymond. "But any life on these planets could be very different from ours. There are a lot of evolutionary steps in between the formation of such planets in other systems and the presence of life forms looking back at us."

The new research effort may allow planet hunters to determine "rough limits" indicating where to search for habitable planets in known systems of giant planets, according to the team, whose research was funded by NASA's Astrobiology Institute headquartered at the NASA Ames Research Center in Moffett Field, Calif.

"Upcoming space missions such as NASA's Kepler and Terrestrial Planet finder and ESA's COROT and Darwin will discover and eventually characterize Earth-like planets around other stars," wrote the authors in Science. ""We predict that a significant fraction of systems

with close-in giant planets will be found to have a Hot Earth or potentially habitable, water-rich planets on stable orbits in the Habitable Zone. "

Source: University of Colorado at Boulder