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David D. Allred
allred@byu.edu

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BOUNDS AND CONDITIONS

A KOLOB IN OUR SOLAR SYSTEM?

By David Allred

In 2003, Dialogue ran adjacent essays by two scientists, David Tolman and David Allred. The two Davids had been students together at Princeton, attending the same student ward. Decades after Princeton, Tolman had left Mormonism and Allred had stayed. Their essays are a fascinating juxtaposition.

In the course of his piece, David Allred ventured for a few paragraphs into a discussion of the planet Jupiter and its role as a governor and protector in our solar system—a type of Kolob. Although the other author dismissed the topic as “fanciful physics,” my own interest was piqued. I asked Dr. Allred, who is now a professor of physics and astronomy at BYU, how he’d feel about fleshing out those paragraphs into a full column. He accepted the invitation and produced the following essay. It’s a fascinating piece that demonstrates how the gospel can illuminate the heavens and the heavens can illuminate back.

Please send me your reflections on Mormonism and issues of science or health at
BOUNDS.AND.CONDITIONS@HOTMAIL.COM.

—RICK JEPSON

HISTORY DEMONSTRATES THAT any attempts to synthesize scripture and science will soon be outdated. Nonetheless, the attempt can be enlightening. Our expanding scientific knowledge brings new vistas on the organization of the universe, and I find echoes of that universe in the scriptures—leaving me with many questions and some speculations.

In this essay, I share one such excursion in natural theology. My text: “Kolob is set nigh unto the throne of God, to govern all those planets which belong to the same order as that upon which thou standest” (Abraham 3:9). In the last decade and a half, a number of published astronomical observations and numerical simulations have made me wonder if the planet Jupiter might be a governor, a type of Kolob, set at the creation of the solar system to govern and protect the earth and to sustain life on it over geological time.

I do not think that Jupiter is *the* Kolob mentioned in the Book of Abraham. Where that Kolob is, I do not know. Nor am I certain that the Book of Abraham is meant to be a textbook of science; it may have more meta-

physics than astrophysics. But however the text is meant to be read, I believe that we can enrich its interpretation by examining the role of Jupiter in our solar system. If nothing else, Jupiter shows us that one sphere can indeed govern and protect another.

There is evidence that Jupiter’s motion through the heavens has interacted with the earth in at least three positive ways: Jupiter stabilizes the earth’s orbit, protects it from asteroids and comets, and may have delivered water and other crucial elements for life to an infant Earth early in its formation.

ABRIEF history of astronomy may be helpful. Modern science emerged three centuries ago as observers came to recognize the physics behind the clockwork regularity of the heavens. With this realization came the ability to predict where planets, comets, and moons would be in the future. This sense of an ordered universe, along with the realization that its laws were discoverable and comprehensible by people, helped fuel that eighteenth-century confidence we call the Enlightenment. But scientists at the time of Newton couldn’t

compute the orbit of a body acted upon by two or more other astronomical objects. They could only approximately calculate even the simple motions of the sun, the earth, and the moon. Since gravity is unbounded by range, a host of heavenly bodies interact in concert, tugging at each other as they pass through their orbits. It turned out that the heavens were not a perfect clockwork after all. Certainly not over millions of years.

Over the last two hundred and fifty years, scientists got better at understanding how, over many orbits of the planets, the effects nearly cancel each other out, as well as the bounds and limits to the effects that don’t cancel each other out. But until recently, it wasn’t possible to think about “running the heavens forward or backwards” to see what the solar system would look like at a given time millions of years in the future or the past. With the current speed and power of computers, this is now possible. We’ve been able to probe the dynamics of our solar system not just by running the clock forward and backward, but even by simulating how the solar system might have taken its current form or how changes in its organization would affect our planet. One set of such simulations examines the influence of our system’s largest planet, Jupiter.

JUPITER is colossal.¹ It carries more than twice the mass of the other seven planets in our solar system combined.

It has 320 times the mass of the earth and three times that of the next biggest planet, Saturn. If we were to imagine our solar system as viewed from one of our neighboring stars—even with the best telescope we have imagined—we’d likely see just two smudges: the sun and Jupiter. Maybe a third in Saturn. The earth might not show up at all.²

Jupiter’s gravitational effects are massive. Although the sun is more than a thousand times the size of Jupiter, the planet’s motion carries an angular momentum larger than the sun’s. This means that it has enough force to perturb the orbits of the planets of the inner solar system—Mercury, Venus, Earth, and Mars. In essence, Jupiter is able to push these planets around.³ Of course force is reciprocal, so the inner planets do some pushing back. But it’s like four children jumping on a trampoline with an adult: Jupiter is so massive that it alters the orbits of its neighbors much more than they alter its orbit in return. Calculations show that all this pushing around has kept the earth’s orbit nearly circular, neither expanding nor contracting over the eons.



DAVID ALLRED received his Ph.D. in physics and physical chemistry from Princeton University in 1977. He has worked in industry, U.S. National labs, and several universities, including Brigham Young University where he is a professor of physics and astronomy. He and his wife Janice are the parents of nine children. This essay is adapted from “What the Universe Means to People like Me,” *Dialogue: A Journal of Mormon Thought* 36, no. 1 (Spring 2003): 109–25.

I SEE THE
EARTH AND
ITS COSMIC
ENVIRONMENT
AS AN
EXPRESSION
OF GOD'S
CONSTANT
LOVE FOR US.
AS WE LEARN
MORE ABOUT
THE HEAVENS
AND THE
EARTH, I
EXPECT WE
WILL SEE MORE
EVIDENCES OF
THAT LOVE AND
FIND MORE
RESONANCES
WITH THE
SCRIPTURES.



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Reflecting on this influence, one can see massive Jupiter acting as a “ruler” or a “governor” of the inner planets—which are often termed the “terrestrial planets” because of their similarity to Earth. This brings to my mind Abraham’s description of a sphere set “to govern all those planets which belong to the same order as that upon which thou standest.” Jupiter governs the orbits of the four terrestrial planets, the order of planets to which our own belongs.

Jupiter’s role in our solar system may be exceptional in the universe.⁴ Although we’d expect most long-lived planetary systems to function much like our own, in fact there is evidence that our system is uncommon in the galaxy. Just over two decades ago, we knew of no extrasolar planets or planetary systems. We reasoned about how our system had come into existence to produce what we saw and then extrapolated that other planetary systems ought to resemble our own. Then, just about a decade ago, the first planet revolving around another star was confirmed. Now we know of more than 210 such planets and nearly as many systems around other stars.⁵ Only a few of these closely resemble our own solar system.

Because they make solar systems easier for us to find, all the systems discovered so far have a Jovian planet. These planets are gas giants similar to four of the planets in our solar system: Jupiter, Saturn, Uranus, and Neptune. But none of these systems matches our own, with a Jovian planet moving in a nearly circular orbit sufficiently distant from its star.⁶ Instead, their gas giants fall mostly into two unexpected classes: “hot Jupiters” and “eccentric Jupiters.” Both types make

their systems inhospitable for a planet like our earth.

Hot Jupiters lie at very small orbital distances from their parent stars—so close that their “years” may be as short as three Earth days long. Because their motion necessarily affects the motion of the stars they orbit, hot Jupiters are relatively easy to detect, so they may seem more common to us than they actually are. But even with that in mind, they are surprisingly common. Our current hypothesis is that these giants form at a great distance from their parent stars and then slowly draw closer. In the process, a hot Jupiter would destroy any terrestrial planets inside of its tightening orbit by pushing them into the star.

Almost all known Jovian planets that are not hot Jupiters are instead eccentric Jupiters. These planets, even when set distantly from their parent stars, have astonishingly elliptical orbits. In our own solar system, the earth can tolerate the eccentricity of smaller planets like Mars and Mercury because their gravitational effects are small. But if Jupiter had an elliptical orbit, life might not be possible on our planet.⁷

Having a nearly circular orbit has helped stabilize the earth’s climate, allowing complex life to develop and diversify. We’ve known for some time that Jupiter moves in a rather circular orbit around the sun every twelve Earth years and that, via gravitational interaction, it keeps the earth and other terrestrial planets in nearly circular orbits as well. Until data from other systems came in, we assumed this arrangement was the norm.

Eccentric Jupiters tend to clear out large chunks of space. Over the course of eons,

they destabilize the orbits of smaller objects—making their orbits more elliptical. They might also absorb smaller planets, smash them into the star or other planets, or even throw them out of the system into the deep freeze of interstellar space. Instead of being governors for terrestrial planets, most Jovians in the universe seem like destroyers.

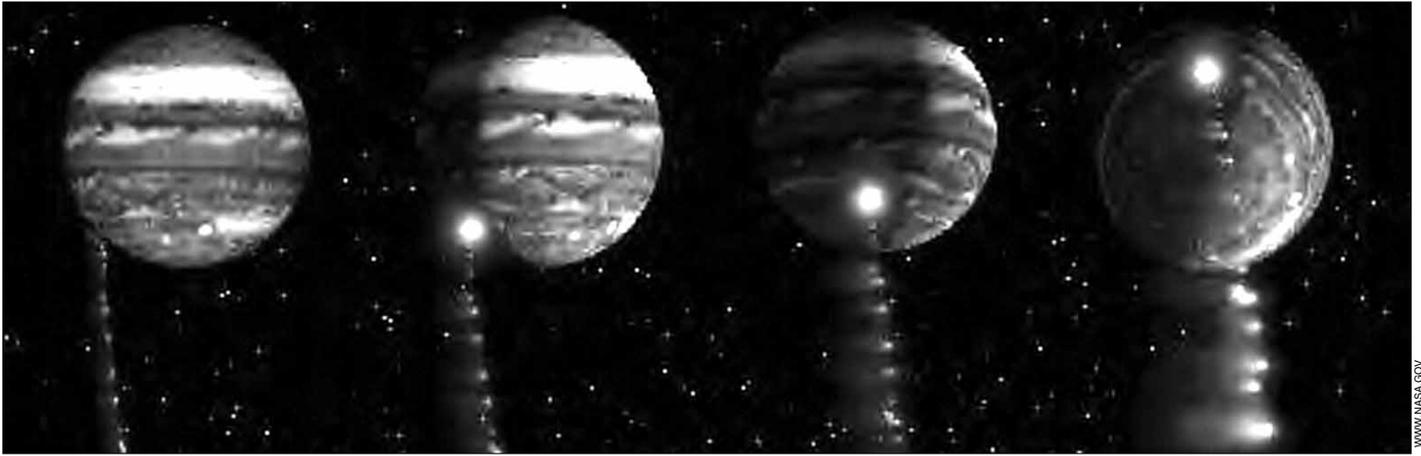
JUPITER is also a protector. It shields us from collisions with killer comets. This shielding became apparent when astronomers began computing where comets end up after completing thousands of orbits, influenced all the while by the gravity of the objects they pass by. They found that these long orbits often cut across the paths of several planets in our solar system, a fact which destabilizes the comet’s direction. A planet’s gravitational field can absorb a comet or sling it either into the Sun or into deep space.

With computer simulation, we can examine Jupiter’s role in clearing our solar system of comets. By replacing Jupiter with a Jovian the size of Saturn and running through millions of years, we see that the rate of KT class, or “dinosaur killer,” comets bombarding the earth increases between ten- and one hundredfold. If there were no planet at all in Jupiter’s place, the rate would increase another hundredfold. The frequency of a 10-kilometer body hitting the earth would increase from once every hundred million years to once every hundred thousand years. This kind of event would be devastating for complex life on Earth.

We live in a dangerous neighborhood, but we have powerful, helpful neighbors. Jupiter soaks up most comets or hurls them into the sun or out of the solar system before they can reach the earth. This point was brought home in 1994 when Jupiter disrupted the recently discovered comet, Shoemaker-Levi-9. Pulled from its course, the comet broke apart and slammed into Jupiter. Many wondered if we’d be able to see the impact. Jupiter is huge and has no solid surface. Its atmosphere is tens of thousands of miles thick. So many thought Jupiter would just swallow up the fragments without any trace. But it didn’t, and the effect was sobering.

The collisions occurred on the side of the planet turned slightly away from the earth, but the flash and expelled gases could be seen by telescopes. Several hours later,





COMET SHOEMAKER-LEVI 9 COLLIDING WITH JUPITER

On 16–22 July 1994, more than twenty fragments of comet Shoemaker-Levy 9 collided with the planet Jupiter.

when the planet's rotation brought the impact area into view, there was a dark spot almost 8,000 miles in diameter where the largest fragment hit. If the comet had hit the earth instead, our entire planet would have been devastated pole to pole within a few days.

JUPITER may also have been instrumental in the initial organization of the earth.⁸ Jupiter's gravity blocked the formation of a planet between itself and Mars, instead leaving the small chunks of leftover matter that form the asteroid belt. Some theorize that Jupiter also brought water to the earth more than four billion years ago by flinging chunks of cold, ice-bearing rocks and hydrated minerals from the outer reaches of the asteroid belt towards the inner planets. This conjecture is based on the ratio of the common isotope of hydrogen in water to that of the heavy isotope, which on Earth is about 7000 to 1. That ratio is not found in comets but is in meteorites thought to come from the regions of the asteroid belt furthest from the sun, nearest the orbit of Jupiter. An eccentric Jupiter, by contrast, would be expected to deliver less water to terrestrial planets.

WE live in an interesting time. The more we learn about the universe, the more appreciation I have for the earth we have been given to live on and for the factors that went into creating it, that protect and stabilize it, and that help to keep it the beautiful and nurturing garden it is. One of those factors is Jupiter. It was probably instrumental in the creation of the earth by providing our planet with the right amount of water. It protects us from most destructive comets, and it does not perturb Earth's orbit out of near circularity.

The Lord's words teach me that this state of affairs is not accidental. Perhaps Jupiter can be seen as a type of Kolob. It is a governor of the earth and its neighboring terrestrial planets. In this light, I see the earth and its cosmic environment as an expression of God's constant love for us. As we learn more about the heavens and the earth, I expect we will see more evidences of that love and find more resonances with the scriptures. Advances in science help us to understand and appreciate the scriptures in new and interesting ways.

NOTES

1. Jupiter facts can be found at Wikipedia, which offers the interesting note that the planet's name in English is a reduction of "Deus Pater," meaning "God father." ("Father God" would be a looser but more illuminating translation.) Also NASA has a fact sheet available at: <http://nssdc.gsfc.nasa.gov/planetary/factsheet/>.

2. NASA's Terrestrial Planet Finder (TPF) mission may get postponed. But a "starshade" has been proposed as a relatively cheap mission which could give the James Webb Telescope the capacity to see small objects near a bright star. In addition, Darwin may fly. Sooner or later someone will try a project which may make it easier to see planets. See for example: http://www.usatoday.com/tech/science/columnist/vergano/2007-02-04-starshade_x.htm.

3. Saturn lies about ten times farther from the sun than does the earth, so its average effect on the inner planets would be more than a factor of ten smaller than Jupiter's. Therefore, Saturn's effect on the earth's orbit can be disregarded for this discussion.

4. The best book on this theme that I know is the one that first made the case: Peter Ward and Donald Brownlee, *Rare Earth: Why Complex Life Is Uncommon in the Universe* (New York: Copernicus, 2000). Both Ward and Brownlee are professors at the University of Washington. The first is a geologist and paleontologist; the second, an astronomer and astrobiologist. Pages 235–42 contain an excellent analysis of the potential role of Jupiter in keeping the earth habitable for animal life.

The book is written to be accessible to educated amateurs and makes a case for the "Rare Earth" hypothesis, an alternative to what is sometimes termed the "Copernican" hypothesis. The Copernican hypothesis is the idea that just as the earth is not the center of the universe, so too the earth is nothing special in the universe and that complex life will therefore be common in the universe. Both hypotheses have stimulated active thought and investigation. It may take considerable time and investigation to provide definitive evidence for one model over the other.

5. An up-to-date, extensive, and easy-to-search catalogue is at <http://exoplanets.org/planets.shtml>.

6. The Jovian planets orbiting the star 47 Ursae maj. have nearly circular orbits, but these planets are more massive and closer to 47 UMa than Jupiter and Saturn are to our sun.

7. Jonathon I. Lonnie, "The Occurrence of Jovian Planets and the Habitability of Planetary Systems," *Proceedings of the National Academy of Sciences* 98, no 3 (2001): 809–14.

8. Sean N. Raymond, Thomas R. Quinn, Jonathon I. Lunine, "Making Other Earths: Dynamical Simulations of Terrestrial Planet Formation and Water Delivery," http://arxiv.org/PS_cache/astro-ph/pdf/0308/0308159.pdf.



LUNAR ECLIPSE

The night sky nibbles
the biscuit of moon.
Bite by bite,
the moon melts in the mouth
of the night.

—KRISTIN BERKEY-ABBOTT