

**LETTERS TO PROGRESS IN PHYSICS****Commentary on the Liquid Metallic Hydrogen Model of the Sun II.  
Insight Relative to Coronal Rain and Splashdown Events**

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Coronal rain represents blobs of solar material with a width of  $\sim 300$  km and a length of  $\sim 700$  km which are falling from the active region of the corona towards the solar surface along loop-like paths. Conversely, coronal showers are comprised of much larger bulks of matter, or clumps of solar rain. Beyond coronal rain and showers, the expulsion of solar matter from the surface, whether through flares, prominences, or coronal mass ejections, can result in massive disruptions which have been observed to rise far into the corona, return towards the Sun, and splashdown onto the photosphere. The existence of coronal rain and the splashdown of mass ejections onto the solar surface constitute the twenty-third and twenty-fourth lines of evidence that the Sun is condensed matter.

*As the laws of a liquid are different from those of a gas, a liquid star will behave differently from a gaseous star, and before we can predict the behaviour of a star we must know the state of the matter composing it.*

James Hopwood Jeans, 1928 [1]

The presence of coronal rain within the active atmosphere of the Sun has been recognized for less than a decade [2–5]. Coronal rain corresponds to “cool and dense matter and not waves” [5]. It appears to be “ubiquitous” and “composed of a myriad of small blobs, with sizes that are, on average 300 km in width and 700 km in length” [5]. When it aggregates, coronal rain can lead to larger clumps called “showers” [5]. Their rate of descent towards the solar surface can approach  $120 \text{ km s}^{-1}$ . However, such rates of descent are inferior to those inferred from the Sun’s gravitational field, suggesting that they are restricted in their downward motion by gas pressure in the underlying solar atmosphere [5]. These findings are incongruent with the idea that the density of the chromosphere is in the  $10^{-12} \text{ g/cm}^3$  range, as currently advanced by the gaseous solar models [6]. Such densities would be associated with very good vacuums on Earth. As such, it does not seem reasonable, based on these findings, that the chromospheric densities associated with the gaseous models can be correct [7]. At the same time, theoretical models relative to coronal rain now rely on “heating and condensation cycles” [4, 5], despite the fact that the gaseous models of the Sun preclude all material condensation. In the end, it remains more plausible to account for the behavior of coronal rain by invoking true condensation, as seen in the liquid metallic model of the Sun [7]. This constitutes the twenty-third line of evidence that the Sun is comprised of condensed matter (see [7] and references therein for the others).

In addition to coronal rain, the mass ejection event, witnessed on June 7, 2011, was particularly instructive relative

to the nature of the Sun [8, 9]. On that day, a tremendous disruption occurred on the solar surface which projected material well into the corona, prior to its subsequent descent back onto the Sun. Upon striking the solar body, the multiple points of impact immediately brightened – revealing clear and distinct surface behavior on the photosphere [9]. Such visualizations highlight that the solar surface is not an optical illusion, but, indeed, acts as a real surface. Such “splashdowns” constitute the twenty-fourth line of evidence that the solar body is comprised of condensed matter. In addition, they provide complementary evidence that flares, prominences, and coronal mass ejections are also characterized by the existence, at least in part, of condensed matter.

Impressive disruptions of the solar surface have also been associated with comets, although initial analysis apparently revealed that such events were not associated with the impact of such objects onto the photosphere [10]. In the end, additional study may well reveal that comets have the ability to disrupt the solar surface, either directly through impact or indirectly by disrupting magnetic field lines above the surface.

Such visualizations highlight that the solar surface is not an optical illusion. It appears and behaves as a true liquid surface. In addition, coronal rains and mass ejection splashdowns indicate that the outer atmosphere of the Sun can support localized regions of condensed matter.

**Acknowledgment**

The May 10–11, 2011 solar event [10] was first brought to the author’s attention by Patrice Robitaille.

**Dedication**

This work is dedicated to my brother, Patrice, in profound gratitude for many years of support and encouragement.

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