Unable to distinguish between hydroxyl radicals from water ice and hydroxyl groups from methanol using lunar spectral detection

--- A problem of sufficient urgency and significance

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* The absorption strength of hydroxyl radicals and hydroxyl groups are all 2.9µm, so it is easy to confuse them;

* LCROSS is unable to distinguish between hydroxyl radicals from water ice and hydroxyl groups from methanol;

* The presence of water ice in lunar polar craters is worthy of renewed scrutiny.

Abstract:

The absorption strength of hydroxyl radicals and hydroxyl groups are all 2.9µm, so it is easy to confuse hydroxyl radicals and hydroxyl groups when interpreting M^3 spectra data. I do not doubt the ability of LCROSS to detect OH from water, but only suspect that LCROSS is unable to distinguish between hydroxyl radicals from water ice and hydroxyl groups from methanol because it ignores their spectral identity. Hydroxyl radicals and hydroxyl groups are two different concepts: hydroxyl radicals belong to the ion, whereas hydroxyl groups are the type of functional groups in organic matter. We have reason to suspect hydroxyl radicals that LCROSS claimed to discover on the Moon might actually be hydroxyl groups from Moon's methanol. It seems that all our misconceptions about water ice in lunar polar craters might be due to the neglect of the chemical role of lunar methanol. It is necessary to conduct in-depth research in this field in the future.

Plain Language Summary:

I lean towards there being far less water on the Moon than is generally stated in the news. Moreover, I believe we all agree that many possibilities other than water ice (solid H_2O) exist that can explain many of the observations that are often described as "water on the Moon" by various publications (especially newspapers/websites). Another place I see the data misinterpreted and/or misquoted is when people are trying to sell something - especially people who want to use lunar water as a resource. Well, it's time to take the fresh look at whether the Moon has lots of water ice.

Keywords: hydroxyl radicals; water ice; hydroxyl groups; methanol; solid hydrogen; confusion.

1. Introduction

Albert Einstein once said: “The formulation of a problem is often more essential than its solution, ” (Einstein, 1938).

Now, I find a problem that we may have not been paid attention to before: the absorption strength of hydroxyl radicals from water ice and hydroxyl groups from Moon's methanol are all 2.9µm, so it is easy to confuse hydroxyl radicals and hydroxyl groups when interpreting M[3] spectra data. So that, the presence of water ice in lunar polar craters is worthy of renewed scrutiny.

2. Lunar methanol

2.1 Source of lunar methanol

Methanol (CH_3OH) is an important interstellar molecule. Solid methanol is an important constituent of ice in the interstellar medium(Dawes et al., 2016). CH_3OH has been observed in comets and on the surfaces of trans-Neptunian objects(Dalle, 2014). In dense molecular clouds, CH_3OH is observed to be one of the most abundant constituents of ice after H_2O and CO (Pontoppidan, 2004).

2.2 Evidence of the presence of methanol on the Moon

· "Carbon dioxide, methane, ethylene, and methanol were all found to be part of the LCROSS plume.” (Colaprete et al., 2010).

· It is necessary to point out that Qasim D. et al. studied the formation of interstellar methanol ice prior to the heavy CO freeze-out stage, and got an important result: CH_3OH formation is shown to be possible by the sequential surface reaction chain, $CH_4 + OH \rightarrow CH_3 + H_2O$ and $CH_3 + OH \rightarrow CH_3OH$ at 10–20 K (Qasim et al., 2018), which much like the situation of lunar polar craters (26 k).

The end products of various chemical reactions above are methanol(CH_3OH) and water(H_2O)(Qasim D et al., 2018).

The water will be consumed with methanol to produce vast quantities of molecular hydrogen, with a very high efficiency of low-temperature hydrogen production using Pt/α-MoC catalysts, which please see in detail in Section 2.4.

2.3 It is easy to confuse hydroxyl radicals and hydroxyl groups when interpreting M[3] data

The "absorption strength” of hydroxyl radicals and hydroxyl groups are all ~2.9 µm.

·The absorption strength of hydroxyl radicals is ~2.9 μm (Li & Milliken, 2017).

·"A broadband absorption at 2.9 μm due to the presence of the hydroxyl groups in the calcium aluminate work.” (Zhao et al., 2015).

· "The Moon Mineralogy Mapper (M^3) on Chandrayaan-1 has recently detected absorption features near 2.8 to 3.0 micrometers on the surface of the Moon. For silicate bodies, such features are typically attributed to hydroxyl- and/or water -bearing materials.” (Pieters et al., 2009).

· "The overlapping of observed CH_3OH vibrational absorption bands with H_2O and silicate absorption features.” (Dawes et al., 2016).

Therefore, it is easy to confuse hydroxyl radicals and hydroxyl groups when interpreting M^3 data.

However, hydroxyl radicals and hydroxyl groups are two different concepts: hydroxyl radicals belong to the ion, whereas hydroxyl groups are the type of functional groups in organic matter, at least exist in methanol (Gracia et al., 2008).

2.4 A new theory

The large amount of methanol exists on the Moon provides us with a new way of thinking:

· Hydroxyl radicals that LCROSS and Chandrayaan-1 claimed to discover on the Moon might actually be hydroxyl groups from Moon’s methanol.

· On our Earth, methanol can react with water to produce molecular hydrogen, with a very high efficiency of low-temperature hydrogen production using Pt/α-MoC catalysts (Lin et al., 2017). The same low-temperature catalysis applies to lunar polar craters that receive no sunlight.

Do these three chemical elements, platinum(Pt), carbon(C) and molybdenum(Mo), exist on the Moon? The answer is yes. The evidence is as follows:

·Platinum(Pt) --- "Platinum is abundant on the Moon.” (Shieber, 2018).

·Molybdenum(Mo) --- "The Russian Luna 24 mission discovered a single grain (1 × 0.6 micrometer) of pure molybdenum in a pyroxene fragment taken from Mare Crisium on the Moon.” (New World Encyclopedia, 2018).

· Carbon(C) --- "Lava associated with lunar fire fountains contained significant amounts of carbon.” (Saal et al., 2015).

Therefore, the water brought by comets and asteroids and the one caused by solar wind and various chemical reactions(Qasim D et al., 2018) within lunar polar craters has been exhausted by reacting with the methanol in the presence of Pt/α-MoC catalysts. These reactions formed large amounts of hydrogen, thus clarifying the question NASA raised that "Scientists have long speculated about the source of vast quantities of hydrogen that have been observed at the lunar poles.” (NASA Content Administrator, 2017).

So, what is the state of the vast quantities of hydrogen in the polar craters of the Moon now?

It found mid-winter, nighttime surface temperatures inside the coldest craters — the south western edge of the floor of the Hermite crater, the southern edges of the floors of Peary and Bosch craters in the northern polar region — can dip as low as minus 249°C (26K) (NASA Lunar Science Institute, 2009), very close to the boiling point of hydrogen (minus 252.87°C) and the melting point of hydrogen (minus 259.14°C) if on our Earth (Anon., 2019a).

We can not exclude the presence of much lower temperatures in the deeper locations of these lunar craters at North Pole, not to mention those at the bottom of lunar craters in the southern polar region where the sunlight never reached. If the temperature in those lunar polar craters above would be measured to further reduce by only 3.87°C, it would have reached the boiling point of hydrogen (minus 252.87°C) (if on our Earth), forming liquid hydrogen (Anon., 2019a); and 10.14°C lower only, it would have reached the melting point of hydrogen (minus 259.14°C) (if on our Earth), forming brown~black solid molecular hydrogen appearing in snowflake patterns (Anon., 2019b).

Given that the atmospheric pressure on the Moon surface is less than 1/10000 of that one of the Earth surface, and its atmospheric density is 14 orders of magnitude smaller than that of the Earth (Ouyang, 2005), so, what are the boiling point and the melting point of hydrogen on the surface of our Moon, respectively? Is it necessary for the scientific community to conduct some relevant simulation experiments?

The pressure on the Moon is much lower than the triple point of hydrogen, so liquid hydrogen is not stable, it will be either solid or gas.

The existence of the solid molecular hydrogen in lunar polar craters can consistent with facts observed as follows:

1. Total internal reflections
2. Increase in the same sense polarization
3. Planar surface

4. Maximum hydrogen abundance

Therefore, the solid molecular hydrogen in lunar polar craters is easy to confuse with water ice.

3. Discussion

Given the confusion caused by the spectral identity of lunar water ice with lunar methanol, some data showing that the water ice/methanol ratio in lunar polar craters is much greater than 1 should not be credible.

Great efforts, I hope, will be made to improve the resolution of space spectroscopy in the detection of water ice on the Moon after the publication of this article.

4. Conclusions

Chemical reactions still take place even at ultra-low temperatures, such as in lunar polar craters. The end products of various chemical reactions are methanol and water(Qasim D et al., 2018). This water and the one brought by comets, asteroids and solar wind would be consumed with methanol on the Moon, to produce vast quantities of molecular hydrogen with a very high efficiency of low-temperature hydrogen production using Pt/α-MoC catalysts, thus clarifying the question NASA raised that "Scientists have long speculated about the source of vast quantities of hydrogen that have been observed at the lunar poles." (NASA Content Administrator, 2017).

In the field of whether there is water ice on the Moon, my paper explores almost all the major problems below at the same time, thus constituting a system of its own:

·Where did the water go, which was brought by comets and asteroids to the Moon and the one caused by solar wind and various chemical reactions on the Moon (Qasim D et al., 2018)? → the water has been exhausted by reacting with the widespread methanol on the Moon in the presence of Pt/α-MoC catalysts.

·Lunar methanol can react with the water brought by comets and asteroids and the one caused by solar wind and various chemical reactions(Qasim D et al., 2018) to produce large amount of molecular hydrogen, using Pt/α-MoC catalysts, thus clarifying a question NASA raised that "Scientists have long speculated about the source of vast quantities of hydrogen that have been observed at the lunar poles"(NASA Content Administrator, 2017).

·The vast quantities of hydrogen found in lunar polar craters might now be in a solid state, easily confusing with water ice.

It seems that all our previous misconceptions about water ice in lunar polar craters might be due to the neglect of the chemical role of lunar methanol. It is necessary to conduct in-depth research in this field in the future.

Conflicts of interest

There are no conflicts to declare.

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Data Availability Statement

I did not use any new data in my this paper, because “for theoretical papers, or most review papers: Data were not used, nor created for this research”.

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