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YOUNG ASTRONOMERS NEWSLETTER

JULY OF THIS YEAR IS THE 50TH ANNIVERSARY OF THE FIRST MOON LANDING

The media and literature are full of information about the first Moon landing in July of 1969, so this newsletter will simply summarize the important facts. An excellent coverage of the Apollo 11 mission to the Moon is given in the July issue of Astronomy Magazine, and elsewhere.

Apollo 11 crew: Mission commander: Neil Armstrong; Lunar Module (LM) pilot: Edwin (Buzz) Aldrin; Command Module (CM) pilot: Michael Collins.

Launch date: Wednesday, July 16, 1969

Rocket: Saturn V SA-506

Lunar lander: (LM) called "Eagle"

Command service module: (CSM) called "Columbia"

Landing site on the Moon: Mare Tranquillitatis

Mission objectives: (1) perform crewed lunar landing and return to Earth

(2) Scientific exploration of lunar surface by the LM crew: photography, deployment of solar wind experiment, deployment of seismic experiment package, installation of a Laser Ranging Retroreflector, deployment of television camera to transmit signals to Earth, gather samples of lunar surface rocks and soils.

Translunar flight: Two hours and 44 minutes after liftoff (one-and-a-half Earth orbits), a five minute, 44 second burn put Apollo 11 into a translunar trajectory. Rocket components no longer needed were ejected and the remaining units (Command Module and Lunar Module) were reconfigured for the approach.

Check on the LM: On July 18, Armstrong and Aldrin put on their spacesuits and climbed into the LM and checked out the systems, then returned to the CSM.

Reached lunar orbit: On July 19, Apollo 11 flew behind the Moon and began the first orbital insertion maneuver. Final lunar orbit of 62 by 70.5miles was achieved.

Descent to the lunar surface: At 100 hours, 12 min. into the flight, Armstrong and Aldrin entered the LM, and Eagle undocked and separated from Columbia for visual inspection. Michael Collins remained to execute needed duties on Columbia. At 101 hours, 36 min. (Sunday, July 20), when it was on its 13th lunar orbit and behind the Moon, the LM descent engines fired for 30 seconds, to slow the speed and begin descent to a 9 by 67 mile orbit. When Columbia and Eagle re-emerged from the far side of the Moon, the descent engine again fired for 756.3 sec. After 8 minutes, LM was at 26,000 feet above the lunar surface and about 5 miles from the proposed landing site. Some additional firing of the landing engine and steering by Armstrong, was needed to avoid a boulder field. LM (Eagle) landed in the Sea of Tranquility at 3:17 p.m. The landing location was about four miles downrange from the proposed landing spot.

Extravehicular activities: The preparations for exiting the Eagle took over 4 hours. Armstrong was the first to exit the LM (109 hours, 42 minutes into the flight; 11:56 p.m. EST). Twenty minutes later, Aldrin followed down the ladder. During their EVA, the astronauts ranged about 300 feet from Eagle. They deployed the scientific instruments (Seismic instruments detected Moon quakes in the 1970's), took photos, spoke with President Richard Nixon at the White House and collected lunar soil and rocks (48 pounds collected). After 1 hour, 33 minutes on the surface, Aldrin re-entered the LM, followed by Armstrong, 41 minutes

later. The entire EVA lasted about two and a half hours.

Ascent from the lunar surface and redocking with Columbia: After a rest period of about 7 hours, the ascent engine fired to lift Eagle to an initial orbit of 11 by 55 miles. Columbia was on its 25th orbit and adjustments were made so that docking occurred on its 27th orbit (Monday, July 21). Four hours later, the LM was jettisoned and remained in lunar orbit.

Initiating trans-Earth voyage: As Columbia was on its 59th lunar orbit and behind the Moon, a two-and-a-half minute firing of the engines put Apollo 11 on course for return to Earth. One mid-course correction was needed.

Return to Earth: Re-entry procedures were begun on July 24, 44 hours after leaving lunar orbit. After a total mission flight of 195 hours, 18 minutes (eight and one-tenth days) Apollo 11 splashed down in the Pacific Ocean. The spacecraft and the three crew members were recovered by the aircraft carrier, U.S.S. Hornet. The pre-agreed protocol required that the three astronauts had to be kept under a 21-day quarantine to be sure that no pathogens were brought back from the Moon. [NASA website and Wikipedia]

ANALYSIS OF THE MOON ROCKS

John A. Wood and associates at the Smithsonian Astrophysical Observatory were among 140 scientific groups to investigate the Apollo 11 Moon rocks and soil (properly called regolith). The analysis of their samples (two samples for the Wood group) totaling a mass of about 16 grams) is summarized in Sky & Telescope, July, 2019.

Overall, the Moon's surface geology strongly indicates a molten past followed by volcanism, while, at the same time the lunar surface was pummeled by millions of years of meteor impacts. The surface regolith is dominated by igneous rocks and sand; material that had solidified from lava. Virtually no water was found absorbed or adsorbed on the lunar regolith.

So, the Apollo 11 samples showed that about half of the fragments from Mare Tranquillitatis were identified as soil breccias, which were the result of meteor impacts. About 5% of this material were glasses, also the result of meteor impacts. Another 40% were identified as crystalline igneous rocks which had solidified from lava.

Study of the particles was carried out by an electron probe microanalyzer, which could give the chemical makeup (elements) of the samples. This allowed the scientists to identify a mineral, anorthosite, which is classified as a plagioclase feldspar, a silicate mineral high in calcium and aluminum. Anorthosites are believed to originate in molten lava, and being lower in density, tend to rise to the top while more dense minerals solidify at lower levels. Thus, Wood and his colleagues believe that the whole surface of the Moon is dominated by anorthosite which supports the idea that during its maturation, the Moon was totally, or nearly totally, a body of molten lava. This, in turn, agrees with the theory that the Moon formed as the result of a collision of a large body with the Earth and the ejected, hot, molten material consolidated to produce the Moon.

ESTIMATION OF THE MASS OF THE MILKY WAY

Laura Watkins and colleagues, of the Space Telescope Science Institute, have come up with an updated value for the mass of the Milky Way. They used data from the European Space Agency's Gaia satellite as well as roughly 10 years of observations by the Hubble space telescope to arrive at a mass for the Milky Way at one and one-half trillion Suns. The calculation was based on the velocity of 46 globular clusters as they orbited the MW. Using equations dating back to Newton and Kepler, the astronomers arrived at what we expect to be a more reliable value. [Sky & Telescope, July, 2019].

BIRTHDAYS IN JULY:

Georges Lemaitre (Belg.), b. July 17, 1894. d. June 20. 1966. Belgian priest and astrophysicist. One of the earliest to propose the Big Bang (he called it a nuclear origin of the universe). **Hans Bethe** (Ger.), b. July 2, 1906, d. March 5, 2005. (Ger., spent most of his career at Cornell Univ.). Astrophysicist who was involved in working out nuclear synthesis in stars. **Jocelyn Bell Burnell,** (Brit) b. July 15. 1943. Discovered pulsars. Worked under the mentorship of Antony Hewish (see May). **Henrietta Swan Leavitt** (Amer.), b. July 4, 1868, d. Dec. 12, 1921. Discovered the luminosity relation of Cepheid variable stars. Did her work at the Harvard College Observatory**. Vera Cooper Rubin** (Amer.) b. July 23, 1928; d. Dec. 25, 2016. Studied galaxy rotation rates. Proposed dark matter. Did graduate work with George Gamow. **Edward Charles Pickering** (Amer.) b. July 19,1846; d. Feb. 3, 1919. At Harvard U., he recruited over 80 women to study photographs of astronomical bodies. This led to discoveries by Annie Jump Cannon and Henrietta Swan Leavitt (Cepheid Variables).

MOON PHASES IN JULY: New: Tues. the 2nd, and Wed. the 31st; (crescent Moon on July 4th); First Qtr.: Tues. the 9th; Full: Tues. the 16th; Last Qtr.: Wed. the 24th.

THE PLANETS IN JULY: Mercury is low in the west-northwest at dusk on July 1st. Fades rapidly in the following days. **Mars** also fades in the afterglow of the setting Sun. After July, both Mercury and Mars will not be visible for a couple of months. Likewise, **Venus** is dropping out of sight in the east as the Sun rises. **Jupiter** is visible most of the night at magnitude -2.6. It can be seen in the southern sky a little above the star, Antares, in Scorpius. Likewise, **Saturn** is up nearly all night. It comes into opposition on the 9th. It is a little to the left of the Teapot, Sagittarius at magnitude +0.1.

TOTAL SOLAR ECLIPSE ON JULY 2: The total solar eclipse is visible in the eastern Pacific and over Chile and Argentina.

DELTA AQUARIIDS: This summer meteor shower is active from July into August. Peak time is around July 28. Since the new Moon time is occurring to darken the sky, we should be able to see some good meteor activity.

FORSYTH ASTRONOMICAL SOCIETY: Meetings are held the second Wednesday of the month at Kaleideum North (formerly SciWorks) at 7:30 p.m. Visitors are welcome. Check the FAS website to learn about special activities, such as public observations. Outdoor activities are always subject to cancellation due to unfavorable weather. Check the website [www.fas37.org] for any scheduling changes, or call the Kaleideum front desk 336-767-6730 ext. 1000

Special on Independence day: The astronomy club will hold a public observation on Thursday, July 4 at Pilot Mountain State Park beginning at dusk. See the night sky while you also watch fireworks from the distant towns. (weather permitting)

Enjoy your summer. Bob Patsiga, editor