April is the third consecutive month of the year in which the Sun quickly moves northward, increasing its culmination height by another 10°. After the time change to daylight saving time at the beginning of April, the Sun sets after 7 PM, and by the end of the month, it sets after 8 PM.

The month will begin with a strong highlight, which is the occultation of the Pleiades by the Moon in the 16% phase. On April 1, the Silver Globe will pass through the southwestern part of the cluster, occulting, among others, Electra (17 Tau), Merope (23 Tau), Alcyone (25 Tau), Atlas (27 Tau), and Pleione (28 Tau), as well as the characteristic tail of weaker stars to the south-east of them. Poland will be located at the eastern edge of the occultation zone, so the last two of the mentioned stars cannot be observed as occulted in our country. However, in the case of Merope and Alcyone, their occultation will be visible throughout Poland, but their reappearance will be visible only in the northwestern part of the country. The first of the bright stars of the Pleiades will disappear behind the dark edge of the Moon's disk around 10:45 PM, less than 1.5 hours before the setting of both celestial bodies.

The Moon will remain a decoration of the night sky in the first part of the month. On April 2, its phase will increase to 25% and it will simultaneously approach Jupiter by about 5°. The largest planet of the Solar System can be observed only in the first part of the night. Initially, it will be more than 30° above the western horizon, but as the month progresses and dusk sets in later, the planet will lower its position to less than 15°. During this time, its brightness will drop to -2^m, and its disk diameter to 34″. On April 16, an interesting configuration of the Galilean moons will occur: in the evening, Ganymede will appear on its disk, and Callisto will pass just to the south of it.

On April 4, Earth's natural satellite will display a half-illuminated disk, and on the following night, it will meet Mars as well as Castor and Pollux in Gemini. Around 9:30 PM, the Moon will occupy a position about 2° north of the Red Planet and simultaneously 3° south of Pollux. Mars will cover 12° on the sky in April, starting the month less than 0.5° from the shining star κ Gem with an observed magnitude of $+3.5^m$, and by the end of the month, it will reach 2° to the open cluster M44 in Cancer. The planet is quickly moving away from us, which will cause its brightness to drop to $+1^m$ by the end of April, and its disk diameter to 6″. Its phase is still large, nearly 90%, and it can be observed through telescopes.

On the 6th of the month, the Moon will show a 68% phase and will approach the star Asellus Borealis, the northeastern corner of the trapezoid of stars surrounding the already mentioned M44, by less than 0.5°. Two days later, its phase will increase to 85%, and it will be in the central part of the Leo constellation, 3° from Regulus. On the night from April 12 to 13, the Silver Globe will pass through the full moon phase, rising 3° from Spica, the brightest star in Virgo. During the night, the distance between the two celestial bodies will decrease to 1°.

After the full moon, Earth's natural satellite will visit the southernmost part of its orbit, passing deep below the ecliptic. As a result, it will occupy a very low position over the horizon during this time, and on April 18 and 19, it will cross the local meridian even below 10°, making its observations difficult due to terrain obstacles and distortions caused by our atmosphere.

On the night from April 16 to 17, the Moon, at a phase of 86%, will rise around midnight about 1.5° from Antares, the brightest star in Scorpius. It is worth noting, however, the weaker star τ Scorpii, which will be located 1° to the east of the Moon's disk, as it will disappear for about an hour behind the Moon's disk during the night. This phenomenon can be observed over a small area from the North Sea to the Black Sea, with boundaries at the 60° latitude in the north and the Bulgarian-Greek border in the south. In Poland, the occultation will last from around 3:50 AM to 4:40 AM, and the more interesting end of the phenomenon, occurring at the dark edge of the Moon's disk, will take place under a brightening sky.

On April 21, the Last Quarter Moon will occur, and on the 27th of the month, it will pass through the New Moon phase. Unfortunately, due to the unfavourable inclination of the ecliptic, observations of the Moon at this time will be very difficult. It is quite different in the evening. On April 28, just under a day after the New Moon, a very thin crescent of the Moon in the 2% phase will be visible low over the western horizon. On April 29, the Pleiades will be occulted again, unfortunately during the daytime, and in the evening, the Moon will appear 7° from them, showing a disk in the 6% phase. To conclude the month, the Silver Globe in the 13% phase will pass 5° north of Jupiter.

As always in the second half of the month, the Lyrids will radiate, with their peak activity around April 22. The radiant of the shower is located about 8° south-west of Vega and rises at dusk to reach a height of nearly 70° by the end of the astronomical night. At the peak, about 20 events per hour can be expected, and the Moon will not interfere with observations.

Ariel MAJCHER

Straight from Heaven: Again, That Mass Gap

We return to the issue of the 'mass gap,' referring to the hypothetical gap (or void) in the mass distribution of neutron stars and black holes, roughly 3 and 5 $M_\odot$ mass gap between the most massive neutron stars and the least massive black holes. We last wrote about it in Δ^9_{24}, and this time it reappears due to the publication by the LIGO-Virgo-KAGRA (LVK) team. The detection of the interesting GW230529 signal occurred on May 29, 2023, at the beginning of the ongoing LVK O4 observational run (spring 2023 – fall 2025).

During the first three observational campaigns (O1, O2, and O3), the LIGO-Virgo collaboration registered a total of 90 confirmed gravitational wave signals, but since the start of the O4 campaign, over 200 new signals have already been registered, mostly from the binary black hole systems. This is due, of course, to the improved sensitivity of the detectors and, consequently, the larger volume of the Universe from which signals are reaching us can be observed.

The GW230529 signal is particularly interesting because of its source – a binary system – consisted of an object with a mass typical for neutron stars, $1{,}4^{+0,6}{-0,2}, M\odot$, and a second object with a mass of $3{,}6^{+0,8}{-1,2}, M\odot$, located in the 'mass gap'. Signals from binary systems containing a component in the 'mass gap' have been previously detected by the LIGO and Virgo detectors, but this is the first for which the more massive component lies within it. Due to the fact that at the time of detection, only the LIGO Livingston detector (called L1) was operational, the exact position of the signal on the sky could not be determined. Unfortunately, the second LIGO detector (Hanford, H1) was in the process of being activated, and the Virgo detector (V) was completely offline at the time. As a result, the potential electromagnetic radiation that might have accompanied the final moments of GW230529 could not be observed. Astrophysical models predict the formation of a so-called kilonova, i.e., an explosion of hot radioactive matter after the binary system components collide, or the tidal disruption of a neutron star by a black hole before the final collapse.

LIGO and Virgo interferometers use triangulation to determine the source's position on the sky. This requires simultaneous detection by at least two, and ideally three, different detectors to compare time differences in the arrival of the gravitational wave and amplitude and phase differences in the signal at each detector. If only one detector is operational, only the arrival time of the signal can be measured, and the amplitude h of the signal can be estimated, i.e., the distance r to the event, because $h \propto 1/r$.

The detection of GW230529 is important for many reasons. First, it provides further evidence for the existence of compact objects in the 'mass gap,' an area previously considered to be sparsely 'inhabited.' The question remains, however, about the nature of the more massive component: it is presumably a low-mass black hole, but it is not excluded that it is a very massive neutron star (which would be an extraordinary discovery for researchers studying extremely dense matter). From the analysis of the wave that reached the L1 detector, it appears that the more massive component had a non-negligible spin χ (dimensionless angular momentum $\chi = cJ/(GM^2)$, where J is the angular momentum) estimated at $\chi = 0{,}44^{+0,40}_{-0,37}$. However, it is not as large as would be expected in the case of a black hole formed from the earlier merger of two smaller black holes. It is estimated that the merger of two smaller, non-rotating black holes leads to the formation of a black hole with a spin $\chi \approx 0{,}7$, which comes from the transfer of orbital angular momentum of the system to the final spin of the object.

This observation proves that earlier models of stellar evolution and black hole formation processes may need to be refined, as it is already apparent that black holes, especially light ones, can form in many ways, including through neutron star mergers, and perhaps also as a result of explosions of a special class of asymmetric supernovae. It seems more than certain that the 'mass gap' is not a real gap in the mass distribution, but rather a reflection of the current observational limitations. The not entirely successful observation of GW230529 (the failure to detect the phenomenon in electromagnetic waves) is still significant for 'traditional' astrophysics, because now that we have detected GW230529, we will likely detect more events of this type in the future, potentially accompanied by the observation of the electromagnetic signals. These will provide information about the properties and behaviours of compact objects in this mass range.

A. G. Abac et al., "Observation of Gravitational Waves from the Coalescence of a 2.5 − 4.5, $M_\odot$ Compact Object and a Neutron Star", 2024, ApJL 970 L34.

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