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On the inaugural observations of the James Webb space telescope: a short study of The Stephan's Quintet

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DISCUSSION

On the occasion of the inaugural observations of the James Webb space telescope we will briefly analyze the "Stephan's Quintet" [1]. The group is known for the gigantic shock waves to which astronomers claim it is exposed.

How it was born and formed The Stephan's Quintet, is the subject of [*]. Our investigation covers the current situation, as photographed now by the James Webb space telescope.

The calculation is crude: we cannot have observations at different times nor measure any transverse velocity to us. The use of computational code for the N-body system is beyond the scope of this simple processing. Anyhow, I am not sure there would be enough data to set up the simulation (Eccentricity is missing). [**]

This short study is being carried out in the context of the cosmological model named "4-Sphere" and introduced in [viXra:2006.0202] (it works in the Special Relativity context). It concerns the four closest galaxies to each other of that group, thus excluding *NGC 7320*. See NASA's Webb Sheds Light on Galaxy Evolution, Black Holes

In the following table, for each galaxy, we have indicated with $D_{4-sphere}$ the Proper distance in megaparsec (not the Luminosity distance) and with A' the observed angular size expressed in minutes of arc. $Radius_{ly}$ is the radius in light years associated with A', corresponding to the computed value: luminosity distance * angle/2. (In this calculation we should use the Luminosity distance and not the Proper one). The size calculation is carried out in the context of Special Relativity where the effect of the redshift is irrelevant, according to what has been said in [viXra:2207.0051]. The assumed $Radius_{ly}$ is indeed that calculated perpendicular to the direction of the galaxy which is not affected by the Lorentz length contraction. In the last two columns you find the Right Ascension *RA* and the Declination *Dec*.

The Proper distance is appropriate to solve the Kepler two body problem.

Galaxy	*Redshift*	$\theta_{4-sphere}$	$D_{4-sphere}$	A'	$Radius_{ly}$	$RA\ h\ m\ s$	Dec
NGC 7317	*0,02226*	*2,2012E-02*	*93,1*	*0,8*	*34.924*	*22 35 53*	*33 56 42*
NGC 7318A	*0,022365*	*2,2115E-02*	*93,5*	*0,6*	*26.315*	*22 35 57*	*33 57 54*
NGC 7319	*0,022823*	*2,2563E-02*	*95,4*	*1,6*	*71.539*	*22 36 04*	*33 58 33*
NGC 7318B	*0,019449*	*1,9260E-02*	*81,5*	*1,1*	*42.090*	*22 35 58*	*33 57 58*

We immediately note that, excluding the more distant *NGC 7318B*, galaxies are very close to each other. We cannot be sure that their relative speed is simply due to the Galactic Recession. In fact, the average value of the relative speeds between *NGC 7317, NGC 7318A* and *NGC 7319* is 150 $Km\ s^{-1}$ that is an acceptable value as a peculiar velocity. They could be in orbit around their center of gravity.

But we also note that, these size dimensions are comparable with those of the Milky Way equal to 52.850 *ly* and of Andromeda (110.000 *ly*), distant only 0.77 *Mpc* , and in orbit with each other [***].

A crude calculation of the gravitational force for the three near galaxies is necessary. In the absence of data, we could estimate the masses starting from volumes and using the high density of the Milky Way. The result is that NGC 7319, is approximately 8 times greater.

A supermassive black hole (24 * 10^6 $M_\odot$ where $M_\odot = 1.99 * 10^{30}\ Kg\quad is\ the\ Solar\ Mass$) belongs to NGC 7319. It is actually an Active Galactic Nuclei. Barring gravity, other strong interactions can then also be attributed to this object.

We can then assume the center of gravity of the three galaxies in the vicinity of NGC 7319. The setup could be the equivalent of a triple star [2] with *NGC 7317* and *NGC 7318A* that form a binary system of galaxies. With these settings, however, the assumed distances are too high and all trajectories are hyperbolic.

To proceed, with NGC 7319 at rest, we can think that the three galaxies are at almost the same distance from us and that the redshift differences are indicative of peculiar velocities. The two orbits are coplanar, the presence of a radial components of the peculiar velocity v_{pec} make us assume a rotation by 45^0 of the photographed transverse plane around the Celestial Meridian.

After a recalculation we have:

- $m = \ 111 * 10^9\ M_\odot$ $\quad v_{pec-r} = 165\ Km\ s^{-1}$ $\quad$ for NGC 7317
- $m = \ 47 * 10^9\ M_\odot$ $\quad v_{pec-r} = 134\ Km\ s^{-1}$ $\quad$ for $NGC\ 7318A$
- $m = \ 888 * 10^9\ M_\odot$ $\quad at\ rest$ $\quad$ for NGC 7319

The above values v_{pec-r} , refer to the radial component. Speaking of peculiar velocities, we should also consider a transverse component (its redshift is negligible), the latter is not given. But orbits are coplanar, so the relative orbital velocity can be calculated starting from one of its components and from the angle formed with the transverse plane.

Being exclude the use of computational code for the N-body system, we are left with only the simplest solution: We will calculate the orbit of the binary system ($158 * 10^9 M_\odot$) around NGC 7319.

Then, for this very approximate estimate we refer to the image [4] which photographs the position of the three galaxies. The actual radius of each orbit was hypothesized starting from the RA and Dec coordinates of the three galaxies: *0.052 Mpc* for B and *0.109 Mpc* for *H.*

Following, we analyze the result for the Kepler two body problem [3]:

For the binary system *(B)* - Among all possible binary orbits this is the lowest energy one*:*

- current relative velocity $v \approx 4.38 * 10^4 m\ s^{-1}$
- current distance between the two galaxies $r \approx 1.60 *\ 10^{21}\ m$
- quantity $\mu = G(m_1 + m_2) \approx 2.10 *\ 10^{31}\ m^{-2}s^{-2}$
- kinetic energy per unit of mass $K\ \approx 9.59 *\ 10^8\ m^{-2}s^{-2}$
- potential total energy per unit of mass $U\ \approx -1.31 *\ 10^{10}\ m^{-2}s^{-2}$
- total energy per unit of mass $E = K + U\ \approx -1.21 *\ 10^{10}\ m^{-2}s^{-2}$

For the higher hierarchical orbit *(H)*:

- current relative velocity $v \approx 2.33 * 10^5 m\ s^{-1}$
- current distance between NGC 7319 and B center of mass $r \approx 3.36 *\ 10^{21}\ m$
- quantity $\mu = G(m_1 + m_2) \approx 1.39 *\ 10^{32}\ m^{-2}s^{-2}$
- kinetic energy per unit of mass $K\ \approx 2.71 *\ 10^{10}\ m^{-2}s^{-2}$
- potential total energy per unit of mass $U\ \approx -4.13 *\ 10^{10}\ m^{-2}s^{-2}$
- total energy per unit of mass $E = K + U\ \approx -1.42 *\ 10^{10}\ m^{-2}s^{-2}$

Quantity $E < 0$ defines two elliptical orbits: the equivalent of a triple star can be hypothesized as its setup.

Despite being accepted our rough estimates, we are unable to deduce the Laplace–Runge–Lenz vector **A** and the Eccentricity e**.** The lack of data does not allow to go further in the calculation.

The analysis becomes interesting if we consider what Wikipedia reports about the triple star: the higher hierarchical orbit H must be much larger than the binary system's one B. The reason for this arrangement is that, if the inner and outer orbits are comparable in size, the system may become dynamically unstable.

In our simulation we have a current orbital radius only 2 times larger than the other! When the system become unstable, a galaxy can be ejected; all this could involve the big shockwaves, that astronomers speak of.

In the absence of any of the three galaxies we would have obtained an elliptical orbit for the remaining two. The presence of the third galaxy is probably the reason for the instability.

An insight into the dynamics of triple stars can be found in [****], but if as we hypothesized, our triple star setup should really exist, its instability would be certain, given the proximity of the orbits.

[*] – [arXiv:1009.2740]: N-body simulation of the Stephan's Quintet

[**] – [arXiv:2207.03151]: Algebraic and machine learning approach to hierarchical triple-star stability

[***] – [PASJ Japan Vol 57,3]: A Dynamical Model for the Orbit of the Andromeda Galaxy M31 and the Origin of the Local Group of Galaxies

[****] – [arXiv:1710.04698] - On the stability and collisions in triple stellar systems

CONCLUSION

Within the hypothesis of 4-Sphere model, for the Stephan's Quintet (without *NGC 7320*), let us sum up: (a different choice for the orbit plan can invalidate these conclusions)

Excluding the more distant *NGC 7318B*, to look for a cause of the observed strong interactions, we must hypothesize that *NGC 7317, NGC 7318A* and *NGC 7319* are close to each other and that their relative recession speeds are instead radial components of their peculiar velocity.

We assume in the vicinity of *NGC* 7319 the center of gravity of the three remaining galaxies. In this very approximate estimate, the equivalent of a triple star, with *NGC 7317* and *NGC 7318A* that form a binary system of galaxies, is the setup we confirm.

The system may become dynamically unstable, also leading to a galaxy being ejected: this context could involve the big shockwaves, that astronomers speak of.

References from Wikipedia:

[1] - Stephan's Quintet

[2] - Star system

[3] - Laplace–Runge–Lenz vector

[4] - The galaxies in the vicinity of Stephan's Quintet