Surrounding and dwarf galaxies

The vast polar structure mystery (VPOS) [1] is explained by MOND simulations. For that reason, since surrounding behaviour is very close to MOND behaviour, it should be extremely interesting to test those simulations with surrounding. One can bet that the results will be very similar. Indeed, in this particular scenario of a turmoil of the merge of two galaxies, it is, probably, mainly the main features of the two models which are driving the motions. And those features are very similar.

But the present notice focused on another possible origin of this mystery, in which specific features of surrounding are in play. In this possible explanation, one galaxy generates the dwarf galaxies, eventually one of them becoming as big as the first one. There are 3 steps in the suggested formation of the VPOS. The first step is simply the main galaxy generating numerous dwarfs. The second step is when the dwarfs either progressively dissolves in the main one, or get far from it, and then are repulsed progressively from the main galactic plane. The third step might be the creation of a big galaxy, created by the merge of some of these dwarf galaxies.

The latter one, being hypothetic, will not be covered. The first step will be addressed by a simple reasoning and confirmed by 2D simulations. The second one will be addressed by a simple reasoning. It would require 3D simulations.

<u>First step, in two dimensions</u>

The 2D simulations which has been done with surrounding [2] show that numerous dwarf orbiting galaxies are created by the main central galaxy. Therefore at this time they share the same galactic plane.

Let's try to understand why the simulations of surrounding predict a regular creation of dwarf galaxies from a big galaxy. The broad reason for that is the existence of a potential well which is the surrounding sphere, around each amount of matter. The effect of this potential well is that this matter tends to be confined in this sphere. But let's study this in more details.

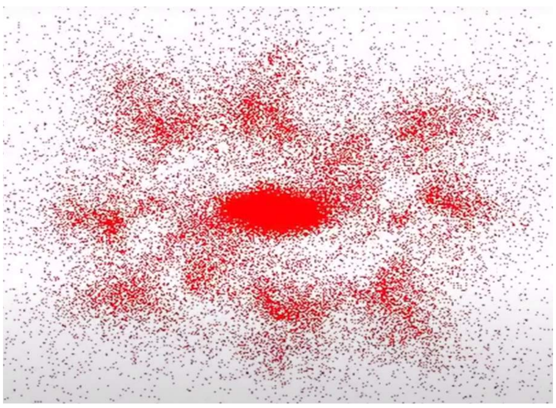
For this let's imagine a bunch of matter distributed along a given plane, in a symmetrical configuration. Let's call *B* this bunch of matter. Then, if the middle of *B* is called the *O* point, *B* is globally unchanged by a symmetry around *O*.

Then let's suppose that a *P* particle escapes from *B*, and goes far from *O*. When the distance *PO* between *P* and *O* is greater than or equal to 15 *kpc*, the gravitational force will start to increase. This is because *B* will start to disappear from the surrounding sphere which is located around *P*. When *PO* will be greater than 15 *kpc* + *r*, where *r* is the ray of *B*, then *B* will disappear completely from this surrounding sphere which is centered in *P*. At this stage the gravitational forces in *P* will be strongly increased by the surrounding effect. Therefore, *B* will appears to *P* as if it were more « massive » (supposing Newton's law still valid). Suddenly *P* will be much more attracted by *B*. The result is that, most of the time, *P* will return back, quickly, inside of *B*.

The above scenario shows that a dwarf galaxy is stable under the surrounding model. But any distribution of matter will tend to regroup in bunchs of matter, like with Newton's law. As a result, any exchange of matter between the inside and the outside of a big galaxy will generate easily those stable bunchs of matter. This will be dwarf galaxies, orbiting of course around the big one, and sharing of course the same galactic plane.

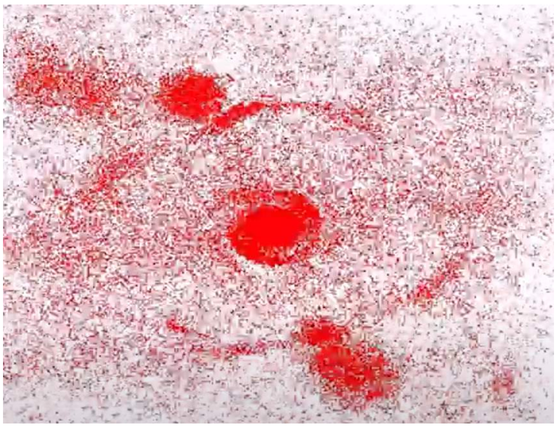
In some simulations the dwarf galaxies are bouncing back on the ring of the big galaxy. This illustrates the stabilty of dwarf galaxies in this model. I have put one of them on youtube because this one shows all the interesting behaviours of the simulations. You find it by searching on google for <<Structure of a simulated galaxy with the surrounding gravitational model>>. Below are extracts from it.

<u>Video at 5:0 sec :</u>



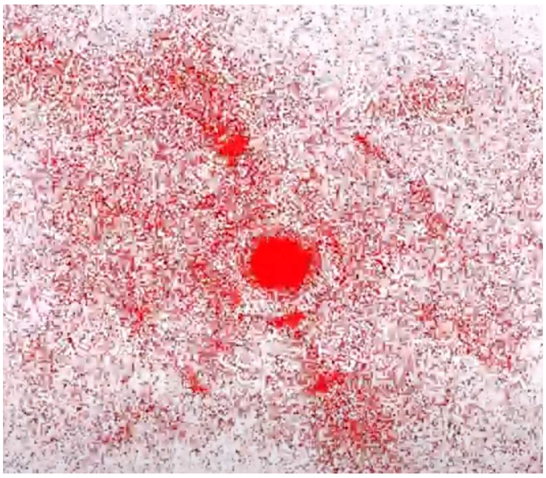
Formation of 8 bunchs of matter, in the spiral arms. Those bunchs of matter will dissolve quickly.

Video at 8:0 sec :



Formation of 2 dwarfs galaxies, one in the upper left, the other in the lower right of the picture.

Video at 8:0 sec, but slightly later :



The 2 dwarfs galaxies are formed. The one in the upper left will bounce 3 times, on the ring of the big galaxy.

Second step, in three dimensions

After this first step, the second step will execute progressively. This second step is that the dwarfs which have been created by the first step will arrange themselves in a plane which will intersect the galactic center but will not be the galactic plane. This plane will be perpendicular to the galactic plane. This is a wired phenomenom at first glance. Because this means that, after the first step, the plane in which the dwarfs are moving will slowly rotate by a 90° angle.

This 90° rotation is understood by considering the potential well and its derived gravitational potential. Once the dwarfs are created, the main galactic plane (MGP) is unstable for them . The first reason for this is that they are far away from the galactic center. Indeed, in the simulations, when they are created, they are allways located at a distance greater than 8 kpc from the galactic center. Therefore the angle from which they are seen from the galactic center is weak. The second reason is that the surrounding sphere in which they are located behaves like a potential well. This has been illustrated above. Let's assume first that there exists dissipation. This assumption will allow to apply the rule of minimum potential configuration for the final result. Once one dwarf is slightly out of the galactic plane, the surrounding value of its surrounding sphere becomes weaker, the surrounding effect becomes greater, acceleration is increased, velocity increases and the ellipse-like trajectory becomes shorter. But mostly, a periodic motion with respect to the MGP starts, in which the dwarf oscillate, periodically passing through the MGP, getting away from it, then returning back to it and so forth. This is a slow motion which must be of course added to the main, ellipse-like, motion. The lengh of this periodic motion increases progressively. This is because at the end points of this periodic motion, acceleration is greater, and increases, with respect to Newton's law. Many dwarfs dissolve themselves in the process after several encounters with the MGP. This confirms that the previous assumption about dissipation was correct. The dwarfs which remain alive after this process, can be possibly driven far away from the galactic center. Therefore they might stay alive even much longer. For them, the maximum potential configuration is reached when those dwarf trajectories and the main galactic plane are perpendicular to one another.

This reasoning is a clue about what might be revealed by 3D simulations, which are very much required.

References

[1] *Monthly Notices of the Royal Astronomical Society*, Volume 513, Issue 1, June 2022, Pages 129–158, https://doi.org/10.1093/mnras/stac722

[2] *EPJ Web of Conferences* **182**, 03006 (2018)