ON ANOMALOUS ACCELERATION, ATYPICAL SHAPE AND OTHERS UNEXPECTED FEATURES OF FIRST DETECTED INTERSTELLAR INTERLOPER ´OUMUAMUA

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ABSTRACT

The first interstellar interloper observed 1I/2017 U1 OUMUAMUA presents unexpected features in a interstellar minor body. This paper shows plausible scenery that cause changes in these features in solar system journey from expected in a interstellar minor body to observed in ´Oumuamua.

Keywords: 1I/2017 U1 - Oumuamua - asteroids - dark matter - pioneer anomaly

INTRODUCTION

1I/2017 U1 OUMUAMUA (´Oumuamua foreafter) is the first interstellar interloper observed in the solar system (Jewitt et al 2017). It was detected by Pan STARRS survey in 2017 October during its flyby of Earth. Peculiar orbital features like e = 1.2 and v_0= 26.2 km s^{-1} points to this conclusion (Mamajek 2017, de la Fuente Marcos & de la Fuente Marcos 2017). The lack of bodies in ´Oumuamua's trajectory with enough velocity to give to ´Oumuamua so much energy with one unique scattering event (Wright 2017) and the very low probability that more than one consecutive scattering event add up effects in appropriate direction support the same supposition.

Therefore one case statistic must be applied and ´Oumuamua must be considered as a typical object in interstellar population of this size. This become important some unexpected characteristics: coma lack, shape, tumbling and non gravitational acceleration.

The aim of this letter is to survey that only one mechanism on its own can explain that all these features can be typical in ´Oumuamua's same location and conditions. The first part shows why coma lack is unexpected. The second part considers the shape to give a hypothetical mechanism which justifies these features. The following part proposes agents for this mechanism and considerations about its presence and plausibility. Later is presented better interpretation of anomalous acceleration and its cause. Finally, a summary presents a brief and complete argumentation; and notes some curious considerations.

THE QUESTION

Theoretical predictions suggest that most interstellar interlopers should be more comet-like (Trilling et al. 2017, Raymond et al 2017), but there are no signs of activity from ´Oumuamua (Knight et al. 2017, Quan-Zhi et al 2017, Ye et al. 2017)

The interstellar minor bodies are objects ejected from planetary systems by different sources. In Solar system the most efficient source was the outer Oort cloud during early system evolution (Laghlin & Batygin 2017). Conventional models for the formation of the Oort cloud predict that there could be as many as 50 comets ejected to interstellar medium for every comet that remains bound to the Sun (Jura 2011). One can speculate that similar events are a common feature of planetary system evolution, and implies that most of interstellar objects are icy, rich in volatile matter, like objects in Oort cloud.

Before and, specially, after ´Oumuamua detection be proposed other sources for ejection of predominant rocky objects to interstellar medium. Thus Cuk (2017) note that binary systems are more efficient ejecting non-volatile small bodies that giants planets of single star systems and, if one of the components is a red dwarf star, are capable of thoroughly tidally disrupt terrestrial planets giving large numbers of 100-m size fragments that can be ejected later. This source have the issue that this catastrophic events are rare, but in binary systems material that is ejected can potentially be heated to high temperatures during close approach, (Jackson et al. 2017) with expectation that around 36 percent of binaries may predominantly eject rocky or substantially devolatiled material. Too has proposed like additional source minor bodies ejected from post main sequence planetary systems (Hansen and Zuckerman 2017) after warm phase that can significantly heat many bodies placed in outer system. Also stellar mass loss during this event increase ejected bodies amount from inner and outer system and implies rocky and icy bodies. And we can considered supernova rare events due can eject huge mass amount, but in this case the issue is his contribution to ´Oumuamua-like population because it is not even clear if objects in this size range could survive the explosion (Rafikov 2018). In consequence after ´Oumuamua detection we expected more presence of rocky bodies in interstellar medium but issue stills effective (Raymond et al 2017), because conventional model of ejection of icy bodies continues more effective, and shows typical interstellar interloper as comet-like rich in volatiles.

Also has take into account (Jewitt et al. 2017, Fitzsimmons et al. 2017), that `Oumuamua inner can be have volatiles and do not show activity at perihelion passage if its surface is crusted enough deep, ≈40 cm skin from Fitzsimmons et al. (2017), for isolate that inner part. This crusted surface is expected by long-duration exposure to cosmic ray in the interstellar medium. But Oort cloud objects had suffered same irradiation during solar system live time and do not show similar volatile diminished skin. This conditions only can expected for interstellar interloper much older than solar system. Is a unknown fraction that prevent its classification like typical interstellar object.

On the other hand the activity lack of typical interstellar interloper is well established. The ´Oumuamua´s lack of coma and activity is clear, motivating its initial classification like asteroid, and is reported in Jewitt et al. (2017), Ye et al. (2017), and others. The lack of a detected icy interstellar body, despite its greater bright and probability of detection, leads to the estimation that dry objects like `Oumuamua are 1000 times more common that icy ones (Do et al. 2018), incompatible with conventional estimations.

THE ANSWER

Looks like ´Oumuamua were an icy body in interstellar space and become dry body in inner solar system. It had suffered a change during its journey to Earth vicinity. If involved mechanism have changed many features we can talk about a metamorphosis better than about a change. And we have a interesting clue of this mechanism by explanation of extreme elongation of ´Oumuamua. This elongation is the greatest observed in any body of solar system.

Domokos et al. (2017) presents abrasion scenarios that from a variety of initial shapes of a body have led highly elongated shapes via the Eikonal evolution. Eikonal model shows that impacts of large to moderate mass ratio with body lead abrasion which tends to make body rounder. In another hand other class of low-energy impacts like collisions with high speed impactors of very light mass relative to body mass has opposite results: it makes body less spherical, reducing sharp edges and planar areas number. The picture is that ´Oumuamua do not have possible large impactors in its trajectory but have suffered impacts from many micrometer-sized dust grains traveling at approximately 50 km/s velocity. Collisions with small mass grains were energetic enough to dislodge splinters from the main body. A further evidence for an abrasion history is the presumably complete lack of dust on the surface.

We can see that with a trajectory toward sun the most effective collisions removing mass were those located in twilight area, on contour respect movement, where the impact energy is less easy to communicate to rest of body like in a zenithal impact. In a body with spin sharp edges and convex surface top are more exposed in twilight zone than concave surface valley and suffered greater located abrasion. But looking body total dimension in a tumbling body must be reach similar "deep" in all directions. This do relatively greater the loose in an minor initial dimension than the same loose in the axis of greater measure of body that remains being the same with increasing of elongation ratio.

Noted that ought many impacts that not cause mass loose must be cause speed loose. Then ´Oumuamua not have all kinematic energy communicated by potential energy of gravitational field. Difference must be radiated. And this suppose pertain temperature increment. Are needed further estimations but maybe can cause or collaborate to dry feature of ´Oumuamua, its unexpected volatile lack. And volatile emissions is one possible cause of tumbling, feature that ´Oumuamua presents. The only one other cause expected for tumbling is a collision with another minor body that is very improbable at interstellar or outer solar system space.

This scenario looks pertinent on various features but have a huge problem: no evidence of enough dust in solar system, in the trajectory of ´Oumuamua. Domokos et al. (2007) pointed to extend action time supposing abrasion during interstellar transit, but this action performance depends of high relative velocities in impacts, that is assured with bodies or clouds in orbit and bounded in a planetary system but becomes less probable in interstellar space. The following section aim y present other agent capable to cause similar abrasion and justify its presence.

SCENERY

The presence of sensible mass of electrons orbiting the Sun in a global cloud of particles bounded in solar system suppose constant sputtering in ´Oumuamua surface with collisions which relative velocity is upper than 25 km/s during all its journey. This collisions may cause abrasion by dislodge

molecules. And this abrasion ought to have similar result that abrasion considered above. The issue is how can be enough electrons at this place.

If we analyze matter creation we can see that protons and neutrons were "condensed" from primordial radiation energy in same proportion in first second of universe. Both are created in same proportion but protons creation continue short time longer than neutrons because were possible with minor temperature in this cooling universe due its slightly minor mass. This cause This short time difference were enough to cause the ratio between protons and neutrons number that exist in present today that is 7/1 (John Hand, Cosmosapiens). The similar reasoning respect electrons with much less mass and a creation lapse of about three minutes with decreasing universe temperature able for its creation implied a very much larger number of electrons respect protons number. Therefore few after began nucleo-synthesis with capture of electrons in neutral atoms, and charge and Pauli´s exclusion principle limits its number in the atom approximately to protons number. This suppose that most of electrons are unbounded in atoms today. They interacting itself by repulsion like collisions and ought to adopt gas comportment in a cloud extended in whole universe trying uniform its density. But they are submitted to gravity and result more concentrate in gravitational fields, like via lactea and solar system (and Earth) where its density is upper. Then, why we can not see it? We can see it looking appropriately but light is not effective neither electrical interactions with neutral charged bodies.

If we look interactions of light with atoms we see really interactions of light with electrons in that atom, and are conditioned by energy levels allows for each electron. The unbounded electrons have not access to energy levels and do not interacting with most of electromagnetic light spectra, maybe only in some extreme frequency.

Respect electrical interactions we must take account that this interactions are powered or conditioned by variations of electric field. The background electric field caused by presence of a huge number of unbound electrons can be great in absolute value. But is very homogeneous and need astronomical distances for show the smallest sensible change of value. Bodies or particles, charged or not, in motion in this homogeneous electric field do not show sensible effects at any speed, including c.

More evidence is sensible of mechanical interactions, collisions with classical matter atoms and molecules, normally in form of pressure contributions for gasses and temperature contributions for all states of matter. For example latent heat of materials in state changes or persistent differences between theoretical predicts and experimental evidences in kinetic-molecular gasses model.

In state, phase, changes of all substances needs add or decrease a fixed amount of thermal energy while temperature (and pressure) stay constant. This energy can not go to (or come from) atoms or molecules inner because its conditions are constants, i. e. constant temperature implied constant kinetic energy. And place this energy in material structure is place it in nothing. Structures are a tool for human reasoning by recognition (or lack) of macroscopic patterns that can not modify interactions between two determined molecules due its short time. Influence supposing simultaneous interaction of a third molecule that must be enough near and results in only one complex interaction. And structures consider number of molecules upper than three. Is better consider that this energy shows the energy of unbounded electrons that entry in (or exit from) observed matter amount increasing (or decreasing) total energy amount. With this scenario by a simplistic estimation, that is out of this paper scope, based in water and ice latent heat and specific heat and considering molecular comportment for H_6O_3 group by stable spherical shape estimation is near of 1 per ten thousandth in mass for unbounded electrons in ice, and 4 per ten thousandth in mass in water. In air estimation is near 1 per thousandth in mass due persistent difference between mathematically strict theoretical

estimation (partial pressure due molecules only) and experimental evidence (total pressure due combined interactions of molecules and unbounded electrons). But these considerations are not useful because 'Oumuamua's media is interplanetary "vacuum".

We must consider another bodies in the same place. Comets and asteroids do not shows so extreme features, almost all features. It can be because their conditions is not a extreme velocity and practically radial direction. In this case the best similar example are human artifacts that doing inverse journey, pioneer, voyager, and other probes. All they presents a curious comportment not observed in natural bodies. A anomalous acceleration denominated "Pioneer's Anomaly" toward sun or backward movement direction, this is not sure because are very proximate directions. It had be investigated during many years (Anderson et al. 2005, Turyshev et al. 2012) and seems that most effect is due by thermal radiation of self-prove. But we can not be sure for a fifth of this accelerations attributed to undetermined changes in cover paint with very extreme effects. If we consider this fifth part of acceleration is due momentum exchange with free electrons orbiting Sun with Pioneer data (Turyshev and Toth, 2010) we find that is enough the presence of approximately 10000 electrons per cubic centimeter ($9.4x10^{-27}Kg/cm^3$) at 10 A.U. distance from Sun. Noted that interactions, collisions, are not elastic neither plastic, because electrons do not rebounds in opposite direction and entry in the body, but do not add its mass to body, acquiring same velocity and leaving body with thermal low relative speed, like a electronic tail of a comet. The momentum exchange in each collision is mass of electron multiply per probe relative velocity.

We suppose gas comportment for orbiting electron cloud then more distant of Sun density ought to be lesser influenced by minor gravity, and maybe slightly corrected by minor temperature. But we can estimate that during last two centuries of its journey the presence of electrons had be upper than 2000 electrons per cubic centimeter with a relative velocity upper than 25 Km/s. These implies more than 5 billions collision in each square centimeter per second in a body surface of many square meters oriented along movement direction. And this conditions during centuries shows so huge collisions number that do plausible many very low probable extreme interactions able cause loss of atoms or molecules, collisions with extremely very much energetic (fast) electrons, two or more consecutive collisions in very short (and improbably) time adding its effects, or others. It seems like abrasion cause by electrons are plausible.

ANOMALOUS ACCELERATION

The observed non gravitational acceleration is deduced by difference between theoretical predicted and observed declination in position of 'Oumuamua. The observed declination is lesser than prediction along its trajectory. This is accounted initially to velocity increase of its velocity that cause change in trajectory shape increasing eccentricity. But this supposition is erroneous because there are not cause for this velocity increase. Initially attributed to cometary activity is incoherent with coma evidence lack and spin evolution (Rafikov 2018). Later be studied posibility that be cause by solar radiation pressure that need so extreme shape, thin less than 1 mm, that do more probable artificial origin than can be caused by a unknown natural mechanism in interstellar medium (Bialy and Loeb 2018). But we must be expect that first observed object is like more abundant object type, and is impossible that there are more artificial objects than natural minor bodies ejected to interstellar space.

If we take in account that 'Oumuamua position observation give us clear value of its declination but give us poor value of distance and we only can suppose velocity we can see that better explanation is velocity reduction. Minor velocity imply minor distance that theoretically estimated. In a trajectory

increasing declination like this suppose a position lower than expected. Loss of velocity is observed yet in interplanetary space. Here we are looking Pioner anomaly in ´Oumuamua´s trajectory. In the scenery proposed above cause is evident. The presence of a tiny electron cloud must be cause a drag force and momentum exchange by collision that reduce body´s velocity. This drag force effects depend of velocity, greater for ´Oumuamua than Pioneer, and electron presence density, greater near Earth than beyond Saturn, and become sensible in this case when in others, asteroids and comet majority, stills present but not sensible.

SUMMARY AND ACKNOWLEDGEMENTS

The expected typical interstellar object is rich in volatile and we can wait that shows like-comet appearance observed in inner planetary Solar system. The 1I/2017 `Oumuamua coma lack and no detection of interstellar interloper with coma in the same survey period despite detection of last these are more probable suggest that coma lack is typical in interstellar object that arrives to inner planetary Solar system. I suppose that these objects suffered a metamorphosis during that journey lead by its great velocity respect inbound orbiting matter and changes many of its features, including volatile matter loss. That implies some type of interaction with some type of matter or radiation. But there are no know conventional objects or matter in path of 1I/2017 `Oumuamua and present radiations also are acting on Oort cloud objects that do not show so dramatically changes . We only can wait presence of dark matter at that place. But this undetected, dark, matter can not be exotic matter because have sensible mechanical interaction with minor bodies if relative velocity is great. It must be unexpected know matter. A universal, near homogeneous and huge background of free electrons unbounded to an atom by its numerical excess and Pauli exclusion principle suppose the presence of a faint cloud of slow electrons bounded in solar system by gravitation, that is near "visually" undetectable because they have not energy levels for interact with photons like those in atoms. In this case we can wait like gas behavior and distribution of particles and mechanical collisions with `Oumuamua and other electrically neutral matter. The momentum transfer in these collisions during long journey suppose acceleration and depleted kinetic energy. Energy lose that must be thermally radiated and suppose increment of temperature. New works are necessary for its estimation, but appearance and tumbling of `Oumuamua suggest that is enough for become inert at least a sensible fraction of its material, that is placed in the surface. Other clue that point to strong character of these interactions is its shape, that looks feasible is caused by erosion. This erosion could fit conditions proposed in Eikonal abrasion model that predicts the extreme elongation in dust presence due high energy of collisions by ´Oumuamua´s extreme relative velocity with any body, dust or particle orbiting Sun. The lack of dust in its trajectory suggest that agent are particles, electrons, orbiting Sun, bounded in solar system. Looks like relative velocity is so extreme that electron sputtering is enough energetic for cause abrasion. More works are necessary on this question. This extreme velocity is too cause for become sensible drag force like deviation of observed position from theoretical position in trajectory at short distance of Earth. We can consider this deviation like evidence of presence of proposed electron cloud at interplanetary space.

A curious consideration is that appropriate name of ´Oumuamua show its messenger role and its so much habitual destiny, its death, like messenger of Marathon and many other. It have come near of us and have give us its message, its unusual and extreme features. But now it follows journey, and mechanism suffered before follow acting. It will lose much mass and will continue increasing its elongation. Is sure that finally breaks in two or more minor bodies. It can not come back to interstellar space in one piece.

I want highlight that electrons mass and charge fit exactly millicharged dark matter constraints from EDGES experiment showed in figure 1 in Berlin et al (2018) and point to they can be all dark matter.

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