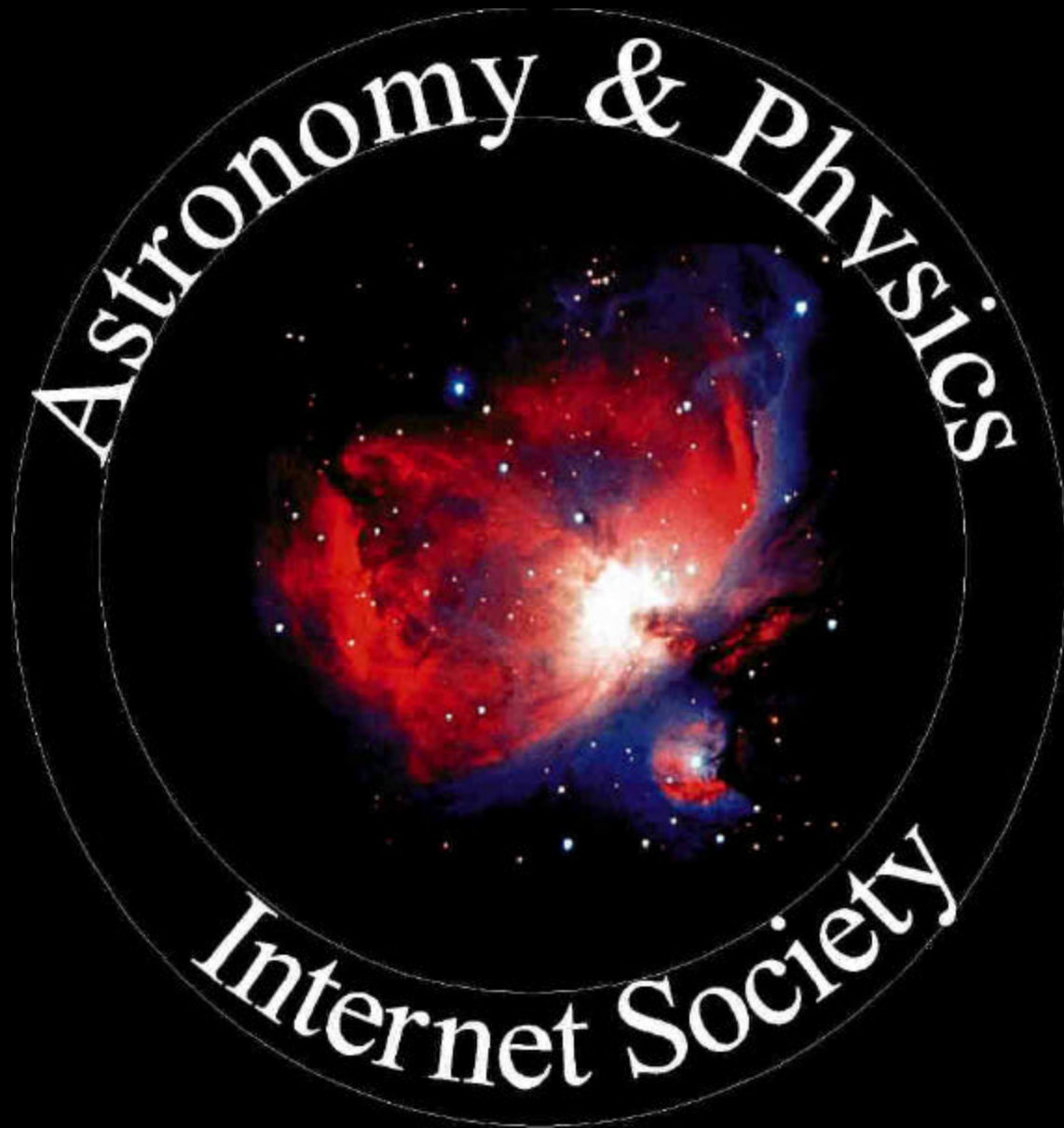


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New Feature - Book Study

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1. Main Article Gravitons & Gravity Waves

In the last issue, we began to explore a concept in Einstein's General Relativity that states we would see gravitational oscillation like those seen in the Electric-Magnetic Force. From observation, tidal oscillation is the predicted oscillation of gravity waves. This means that instead of a rigid clockwork mechanism holding planets in their orbits, we have a spring-type mechanism. This mechanism has planets oscillating in their orbits rather than being at a fixed distance.

The most obvious evidence of gravitational oscillation are the oceans' tides. However, the tides were not viewed as being the result (or evidence) of gravitational oscillation. As a result, this connection will not be seen in many science textbooks. In fact, gravity waves (gravitational oscillation) and gravity particles (graviton) are still being looked for by many physicists. Gravity waves (and particles) are a prediction of Einstein's theory **General Relativity** and are a kin to electromagnetic waves (and particles). It was Einstein's work on

the photon that demonstrated wave-particle duality.

In the classical view, energy needed to be transmitted through matter - this supported the rigid clockwork mechanism. This was the ether of space, through which energy was transmitted. It connected all solid bodies. It provided an invisible conductor through which energy can be transmitted between solid bodies. Consequently, the dynamics, that arose from this view, was that of rigid body mechanics. As such, gravity (in this view) was rigidly fixed and orbits unmoving. Models, of this period, were developed using metal rods, as the mechanism, to fix planets in their orbits. This was based on the obvious *fact* that solids like a rock and the earth were solids and not liquids. This meant that solids had rigid body dynamics, while liquids had fluid dynamics. Consequently, because planets were solid, they were part of rigid body dynamics. The result was, although the tides were observed as an interaction between the moon and earth - they were never viewed as evidence of gravity waves.

Fluid models of behavior (of matter) evolved from the obvious study of fluids (initially just liquids), to more complex behavior in gases and energy. Consequently, it was noticed that the fluid dynamics of a liquid could be equally applied to gases and temperature (a type of energy). This led to postulates that fluid and rigid body dynamics were linked because of a bizarre duality between waves and particles. This concept was brought into reality with Albert Einstein's theory **Special Relativity** which equated matter with energy through the now famous - $E = mc^2$. This theory stated that

particles could behave as waves, and waves as particles. This concept became the basis for the study of atoms as particles - in a new field of particle physics and quantum physics. It was Einstein's work, on the photoelectric effect, that demonstrated the principal behind his equation. Here, in this experiment, light wasn't behaving like a wave (which it was - an electromagnetic wave) but a particle, knocking electrons out of their orbits, producing a current (moving electrons). The result was the light particle called the **photon**. This would become the basis for **Special Relativity**, the subsequent theory of **Quantum Mechanics** and the related fields of atomic and particle physics.

This development had one more consequence, the study of energy flow in solids - **solid-state physics**. In this field, it was found not only did light (a electromagnetic wave) behave as a particle in certain solids, it also flowed through other solids as described by fluid dynamics. The study of this flow of electromagnetic energy (through all states of matter) became the field of **Thermal Dynamics**. While, solid-state physics evolved into electronics, superconductors and semiconductors. Sufficient evidence to make an understanding of wave-particle behavior an observable entity. The next development would come in the study of earthquakes and landslides. In each case there were conditions where solid land started behaving as a fluid. In earthquakes, buildings built on landfill, sand (hardened-compacted) and other such material sank as if the solid material became liquid. When studies were done in the lab, it was found that these solid materials



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started behaving like fluids and solids of higher density sank. This behavior was also then seen in the study of landslides, mud flows (usually volcanic), and in snow with avalanches. The dual behavior of both mass and energy was (and is) observable. Yet, this duality - brought forward in Einstein's **General Theory of Relativity** was (and has) never seen.

Although it was never seen, the evidence was there. Beginning with Kepler, who calculated (via observation and measurement) ellipses for planetary orbits and not the circles of the clockwork view. His work would be more definitively confirmed by the work of Gauss, who - through his work - found that the wandering calendar called the Julian Calendar was strangely the mechanics of the planets, as they oscillated in their orbits. The observed oscillations (wave behavior) were dismissed as errors in the orbit, even when observed and confirmed by the space program. These oscillations - due to gravity - were also ignored like the gravitational oscillations between the earth and moon - commonly known as the tides of the ocean. Yet, further evidence would come from the space program. Beyond the exploration of the moon, NASA also undertook the robotic observation of other planets in the solar system. It was the robotic observer that was sent to Jupiter, that the moon Io came into focus. It was an unusually moon, in that it was highly volcanic. In fact, the moon glows a fiery red-orange with observable eruptions coming from the surface. The question was - why? Why was this moon volcanic and was the source of the energy. Further, exploration of Jupiter's moon Io,

determined that tidal forces caused Io to be highly volcanic. This was evidence of gravitational oscillation in solid material. Further, these gravitational oscillations were causing Io's solid mass to behave as a **particle system** (particles that behave as a fluid) - with gravitational energy being converted to heat (Electromagnetic Energy). This wave-particle behavior is clearly visible in Io. However, observed particle behavior of gravity waves (gravitational oscillation) would come from the **Oort Cloud** (another particle system) and yet again ignored. The Oort cloud is a cloud of material leftover from the formation of the solar system. This cloud, is called a cloud, because it's a particle system that behaves as a fluid and gravitational oscillations (gravity waves) knock individual particles out of the system (just as in the photoelectric effect) that we observe as comets. This behavior, just as the photoelectric effect demonstrated the existence of the photon, demonstrates the existence of the graviton (the gravitational particle). Further evidence is being observed in binary star systems with blackhole candidates pulling mass from its companion star. In fact, gravity wave-particle duality can be observed all over the universe - particularly in large scale objects like galaxies -- massive particle systems that display wave behavior -- that are driven by massive gravitational engines termed **super-massive blackholes**.

Conclusions, from the observed wave-particle duality in the electromagnetic force, can be (and have been - in the article) applied the wave-particle duality observed in the gravitational force. It is clear from the analysis of evidence presented

above that wave-particle duality is observable in both the electromagnetic force and the gravitational force. Further, it can also be stated the much of the evidence for gravitational wave-particle duality existed and was overlooked. Thus, it may, also be said - as with the development of the observation (and study) of wave-particle duality in the electromagnetic force - that the observation (and study) of wave-particle duality in the gravitational force will yield new and exciting physics.

2. Book Study

Chapters 1 & 2

This is the first issue of a new feature that goes beyond the simple book review. In this issue of the bookstudy, we are going to look at the first two chapters of the book, **Flat and Curved Space-Times** by **George F.R. Ellis** and **Ruth M. Williams**. Concepts in this book are central to understanding modern physics - the geometries of space and time.

We are beginning with the first two chapters that lay down the fundamentals required to build a good understanding of the concepts explored in the book. The first chapter begins with an introduction to the concept of space-time and how it compares to the classical view. It does so by looking at the speed of light and the views of motion between classical physics and special relativity. The second chapter builds the fundamental measurements to study the geometries of space-time.



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The first chapter begins with the introduction to the concept of space-time. Almost everyone has heard of the term 3D, but few understand the geometry of even 2D. In geometry the axis of a graph is given a letter to represent that axis. A single line, is a **linear** graph in one dimension (**x**). In high school we all learn of graphs where **x** is the horizontal axis (or the **x** axis) and **y** is the vertical axis (or the **y** axis). To understand this further, a picture is a 2D (x,y) graph, with the **D**, in these graphs, being the dimensions of space. Space, obviously, contains 3 dimensions and can be viewed as a 3D graph. However, with photographs and pictures, the 3D can be projected into 2D. This brings us to the concept of time as a dimension - independent of the dimensions of space. A picture is viewed as the world frozen in time. Thus, when we take pictures in succession, we add the dimension of time **t**, to the dimensions of space. This means that the 2D (x,y) picture becomes the space-time (x,y,t) movie. The time dimension **t** is said to be independent of the space dimensions (x,y,z), because **t** exists along each axis. For example, you can have a (x,y) graph where x and y are at 90 degree angles to each other (orthogonal). In space-time, (x,y,t), **t** is orthogonal to both **x** and **y** - (x,t) and (y,t). (or (t,x) and (t,y) because **t** is viewed as a horizontal axis) This example of space-time in two dimensions of space is extended to three dimensions of space in physics. However, the 2D space-time example of a movie is often used to examine 3D space-time. The reason for this is that a movie is 3D space-time projected in to 2D space-time.

The next component to physics, in space-time, is light and specifically - the speed of light **c**. The speed of light and its function in physics provides a dividing line between classical physics and the physics of Albert Einstein. In Newtonian physics (classical physics) **c** has no effect and is not reflected in the equation of energy **E** - $E = mv^2$. This equation states that E increases as v increases. However, Einstein noticed that this was not the case. He found the **E** was limited by **c**, as expressed in his equation - $E = mc^2$. This equation states that energy does not increase beyond mc^2 , but is limited by it. Expressed in a graph (E,c²), c² is asymptotic to E - reflecting experimental results showing that as E increases v² never equals c². This behavior is described in Einstein's **Special Theory of Relativity**. The result of **c** being constant has very specific effects in the study of astronomy. For astrophysics, it means that the further an object is from earth the further back in time we are seeing it. This has brought up a whole new issue in studying space-time - **simultaneity**. This may seem like a fairly simple issue but these next few examples will demonstrate the consequence of **c**. First, going back to a picture - a photograph taken of a group of friends shows them as they were. Its a picture where **t** is the same for everyone. To be more specific let's say in the summer of 2003 you took a picture of three friends. Obviously, this is a picture as they were in the summer of 2003 and not another time. This is not true for astrophysics. Pictures here will have stars, galaxies, etc. at different times. For example, a picture of Mars is taken, because light takes 20 minutes to travel to earth, the picture shows mars as it was 20 minutes ago, but

for the background stars its millions of years. To put this in perspective - take the picture of your friends (of the summer of 2004) and now it still shows all three friends, but it shows the first friend as he was at 5 years old, the second at 10 and the third as his grandfather (50 years before he was born). This is the issue of simultaneity.

To understand this further we need to understand the geometry of light in space-time geometry. In 1D (x,t) light travels in a straight line. Next, in 2D (x,y,t) is a cone or an open triangle. This is due to the sphere produced in 3D (x,y,z,t). Now, being a sphere in 3D, there are two projections in 2D a cone and a circle. Thus, under certain perspectives, the graph of light travel in space-time is viewed as a cone and as a circle in others. In an example, demonstrating **causality**, they actually provide a good example of simultaneity in real-time 3D space-time. In this example, there's an astronaut on the moon and an observer on earth. The observer, on earth, is watching the astronaut through a powerful telescope. Now, because light takes 1.27 seconds to reach the earth, the observer is seeing events as they were 1.27 seconds ago. This means that if the observer see a rock that will hit the astronaut in 2 seconds, his warning will reach the astronaut 0.54 seconds after the rock hits him. The reason being that the observer is seeing this as they were 1.27 seconds ago and a radio warning will take 1.27 seconds to reach the astronaut.

This consequence of **c**, is further demonstrated in the examination on measuring velocity in Special Relativity. While it was the work of



Michelson-Morely that measured the speed of light, it was Albert Einstein who developed the dynamics of motion near the speed of light - motion in special relativity. The example used in the book for the classical view of motion has a flaw that makes it very confusing. *[observer b on the rocket, I measure the light to be moving past me at c and the rocket moving past me at v - from page 29]* The example has an observer **a** on the ground and observer **b** in the rocket. The rocket is moving past **a** and emits a light signal. The problem is that observer **b** is on (in) the rocket and it's physically impossible for him to see "the rocket moving past me". The problem with the classical view of motion is that the normal equations of motion are not affected by the speed of light. However, experiments and special relativity show differently. In fact, it's from special relativity and the equations of motion that the concept of time travel entered the realm of science. Seen in atomic and particle physics - the concept of time slowing down as the velocity of and object approaches **c** - became a reality. This concept of time dilation is developed in an example based on figure 1.25 (Page 31) . The development of the time dilation uses the equations $d = vt$ (for the distance traveled by the rocket in time **t**), $d = ct$ (for the distance traveled by the light beam to the rocket) and $c^2 = a^2 + b^2$ (the Pythagorean Theorem). The rocket moves a distance $d = vt$. The distance of the light signal from the ground is ct - forming the hypotenuse **c** of a right-angle triangle. This gives the equation;

$$\begin{aligned} (ct)^2 &= (vt)^2 + d^2 \\ d^2 &= c^2t^2 - v^2t^2 \\ d^2 &= t^2 (c^2 - v^2) \end{aligned}$$

$$\begin{aligned} d^2/c^2 &= t^2 (1 - v^2/c^2) \\ (d/c)^2 &= t^2 (1 - v^2/c^2) \\ d/c &= t (1 - v^2/c^2)^{1/2} \\ t &= (d/c) / (1 - v^2/c^2)^{1/2} \end{aligned}$$

But $d/c = t = t_0$
 So $t = t_0 / (1 - v^2/c^2)^{1/2}$
 $t/t_0 = 1 / (1 - v^2/c^2)^{1/2}$
 $t/t_0 = (1 - v^2/c^2)^{-1/2}$

The equation demonstrating time dilation.

Next Issue Chapter 3

3. Introduction to Astronomy Astrometrics

Astronomy, for most of history, was used as a tool - a form of engineering **astrometrics**. History's monuments, like the pyramids, were constructed using astrometrics. This was confirmed when archeologists found accurate astronomical alignment of the pyramids. Throughout ancient history, astrometrics played a key role in the development of society. Astrometrics were the engineering tools of the sky. The first tools seen in history were time tools using solar time for first day and night, and then the general seasons. However, the development of early calendars were not astronomical or solar, they were lunar.

The move to an agrarian society, meant that the primary function of the society was the growing of food. As such, (as archeology has shown), when a society moved into this point (as civilization developed) , the primary astrometrics used were solar and lunar. Initially, solar astrometrics were used to measure the seasons. However, greater control was required, so the lunar calendar was developed to provide

better control over when to plant and when to harvest - for example the harvest moon and Passover. The harvest moon (aptly named) is a view of the moon used to signal the start of the harvest. Passover, is a lunar event that also coincides with spring and the planting of the harvest. However, not all societies were agrarian, some were travelers - like the Polynesians and the shepherds of animal flocks. These two groups were partially nomadic. However, they were not fully nomadic because they often provided agrarian societies with animal products. The Polynesian were sea peoples who brought their societies and structures (farms and all) with them on their boats. These two groups of people understood the sky not as a measure of time, but as a map.

However, astrometrics didn't improve until it was developed for travel and the engineering of cities and monuments. The beginning (which would carry forward to today) started in two places at about the same time 2800 BC. Archeology from both Egypt and Babylon show parallel developments in astrometrics. The measurement system for time began Babylon and brought to its function in the Roman Empire. The Babylonians developed the concept of measurement around a circle - this system became the 1 hour = 60 minutes and 1 minute = 60 seconds. However, the most significant developments came from Egypt - whose astrometrics were passed through the Romans and into the astrometrics of Gauss. Ancient travelers new that they could navigate by the stars of the night sky. However, it took the long lasting Egyptian Empire (2800BC to 1000AD) to move beyond the simple



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star map to the engineering system that became the calendar of Julius Caesar. It was this same system that the scientist Johann Carl Friedrich Gauss developed the work that would eventually give us the **gps system** (gps - global positioning satellite). Sailors and astronomers in the time of Gauss were still using the Egyptian astrometric system for navigation (connected to the Julian Calendar - the best astronomical calendar). In this period, Gauss developed the mathematics needed for surveying. His mathematics applied to astrometrics was so good, that he assisted in the discovery on the minor planet - Ceres. Ceres was first seen by the Italian astronomer Piazzi in 1801. However, Piazzi was only able to observe 9° of the orbit before it disappeared behind the sun. It was rediscovered later in 1801 by a German astronomer Zach, in a position calculated by Gauss.

Gauss' work following this would move astrometrics forward into the modern world. This work would be the pivotal link between the astrometrics of ancient Egypt and the astrometrics of the gps system. The work would begin in 1809 when he published the mathematics and geometry used by astronomers to study the orbits of planets. This work extended the work by both Kepler and Newton. It was Kepler (who was also working on the geometry of orbits) who began the work on conic sections and Gauss who published the geometry of conic sections. Likewise, Newton developed the mathematics of calculus and Gauss extended this work with a publication on differential equations in the same year as his work on the geometry of conic sections.

The important issue to note here is that his mathematical work was not isolated from his work in astrometrics and other sciences. Like Newton and Kepler his mathematics were integrally linked to his research. There was no disconnect between their theoretical work and experimental work. As such, it was also Gauss who made the crucial step forward in the calculation and understanding of experimental errors - later to be the math of error analysis. This understanding translated to his work in geometry and its application to astronomy - and ultimately astrometrics. Thus, it's should be no surprise that the next advances in astrometrics would come during his work on a new observatory. The issue here is a requirement that the observatory be accurately aligned with the night sky. As such, the better the observatory the better the astrometrics required. Something that is said to be circular logic, because a repetitive cycle of logic exists. Specific to this case and the history of astrometrics ; 1. The better the observation - the better the astrometrics ; 2. The better the astrometrics the better the observation. Consequently, Gauss used his improvements in astrometrics to build a better observatory, which in turn would lead to better astrometrics - the astrometrics of the modern world. Thus becoming the link between ancient astrometrics and modern astrometrics.

This link would take the form of geodesics and surveying. This work of geodesics (geometry of globes - particularly applied to earth) would be the next application to map making and become the engineering of surveying. Beginning his work on

the new observatory in 1816, he began working on the mathematics and geometry of geodesics in 1818. This work was eventually published in 1830 and then a definitive book on geodesy in 1847. This work would influence the development on the US Naval Observatory and the 1865 survey of India by Sir George Everest. From here we would also have the development of the latitude and longitude global mapping/coordinate system and the time zone system. All of which are components of astrometrics.

Astrometrics now allowed the connection of the geocentric system with the coordinate system of the night sky. Just like the coordinate system of latitude-longitude, the night sky has a coordinate system **right ascension - declination**. This system allows for an exact mapping of the night sky. Furthermore, it can be fixed to the lat-long system - essential for commercial navigation. As such, the astrometric systems were held by the government and in particular the navy. Who began catalogs of stars in the night sky. Catalogs that would fuel the growth of modern astronomy.



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4. Introduction to Physics

Equations of Motion - force

In this issue we will continue our exploration into the equations of motion by looking at how forces impact motion. In the last issue we explored the simple motion of a can.

i. The first place on the table is x_1 and the place it moves to is x_2 . The difference between the two values is the distance x . So

$$x = x_2 - x_1,$$

However, we usually begin measuring from x_1 so,

$$x_1 = 0$$

then

$$x_2 = x$$

Where x is the total distance moved.

Because it moves from x_1 to x_2 in time t , or it moves a distance x in time t , Then

$$v = x/t$$

Where v is the apparent velocity of the can over the distance x .

But, we saw that, if we examine the situation more carefully, that

At both

$$x_1 \text{ and } x_2, v = 0,$$

So

$$v_1 = v_2 = 0.$$

Because, it starts at x_1 with $v_1 = 0$ (at rest) and stops at x_2 with $v_2 = 0$. then the motion can be described as follows;

At x_1 ,

$$v_1 = 0$$

And

At x_2 ,

$$v_2 = 0$$

With v the velocity the can reaches while being moved from x_1 to x_2 ,

Then, the can accelerates from v_1 to v in time t ;

$$a = (v - v_1)/t$$

But

$$v_1 = 0$$

So

$$a = v/t$$

Next, the can decelerates d from v to v_2 in time t ;

$$d = v/t$$

Because, v_1 accelerates to v and the decelerates to v_2 .

$$v_{\max} = v$$

So,

$$a = v_{\max}/t$$

But,

$$t \text{ (at } v_{\max}) = t_{\max}$$

Then

$$a = v_{\max}/t_{\max}$$

Next (using the structure above)

$$\delta = -(v_{\max} - v_2)/t$$

Where d is the deceleration, because d is distance

Or

$$\delta = -v_{\max}/t_2$$

Where

$$t_2 = t - t_{\max}$$

We now have a better picture of what occurs when the can moves between x_1 and x_2 . Further, we have a

structure with which we can design experiments to further investigate the physics of motion. Obviously, in order for the can to move something has to cause it to move. Using an arbitrary force f , we can develop an equation.

The can has a mass, m

And a force, f

Moves the mass, m

But we see from the above that for the can, of mass m , to move it needs to accelerate a to velocity v .

So we can say that a force, f , accelerates (a) the mass (m)

Or

$$f = ma$$

To start the can moving

And

$$f = m\delta$$

To stop the can,

Further, because

$$f_{\text{start}} = f_{\text{stop}}$$

Newton's laws of motion

And

$$m_{\text{start}} = m_{\text{stop}}$$

Then

$$a = \delta$$

We now have good equations for linear motion - motion in a straight line.



5. Introduction to Mathematics Numbers

The first step to understanding mathematics is an understanding of numbers. This is fairly complex because numbers were different for each civilization. For example, the current number system is called the Arabic number system. Yet, the development of current mathematics stands independent from the origin of the number system. Prior to current mathematics, numbers were more symbolic and less mechanical. This is evident in the Roman and Chinese number system. The Roman system is considered to be the base of our current number system - as applied to the Arabic system. The abacus - a counting device. The math of geometry is created to the Greeks and Egyptian. However, Egyptian papyrus, dating from 2800BC, shows the use of Arabic numbers 3500 years before Arabic influence in the Middle East. Yet there is a common starting point - counting. For this we can use the Roman system as being representative of all other systems.

The Roman system is symbolic like all of the other system, but uses Latin letters (the alphabet) rather than drawn symbols - like the others. All of the symbolic systems function the same using symbols for numbers and as such never needed decimal points (the period is the decimal point). The problem is that all except for the Roman system are not easily accessible. As such, we will use the Roman.

Arabic-Egyptian-Modern

1, 2, 3, 4, 5, 6, 7, 8, 9, 10

All articles are written by Dr. Daniel Carras
Letters to the editor/journal should be sent to: api_apis@yahoo.com

Roman

i, ii, iii, iv, v, vi, vii, viii, ix, x

With i = 1, v = 5 and x = 10

And

iv (1 less than 5) = 4
ix (1 less than 10) = 9

Further graduations;

x, c, m = 10, 100, 1000
v, l, d = 5, 50, 500

So,

1767 = mdccclxvii

Or

m = 1000
dcc = 700

Then

$m + dcc = 1000 + 700 = 1700$

Further ,

dcc = 700
d = 500
cc = 200
 $d + cc = 500 + 200 = 700$

Next

lx = 60
l = 50
x = 10
 $lx = 50 + 10 = 60$

Finally

vii = 7
v = 5
ii = 2
 $v + ii = 5 + 2 = 7$

So,

$1000 + 700 + 60 + 7$
 $m + dcc + lx + vii$
1767 = mdccclxvii

Using dates is a good way to represent the Roman system - and subsequently, all symbolic systems.

Ex.1 1975

a. Split up the number into 1000's, 100's, 10's and 1's

$1000 + 900 + 70 + 5$

b. Find the corresponding Roman Numerals

m = 1000

900 = 1000 - 100
[cm = 1000 - 100 = 900]
cm = 900

70 = 50 + 20

l = 50
xx = 20
[lxx = 50 + 20]
lxx = 70

v = 5

So

1975 = mcmlxxv

Ex.2 1968

a. $1968 = 1000 + 900 + 60 + 8$

b. m = 1000
cm = 900
lx = 60
viii = 8

c. $1968 = mcmlxviii$

Ex.3 1948

A. $1948 = 1000 + 900 + 40 + 8$

B. m = 1000
cm = 900
xl = 40
viii = 8

C. mcmlxviii



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We see from

iii = 3

iv = 4

v = 5

And

xxx = 30

xl = 40

l = 50

As well as

ccc = 300

cd = 400

d = 500

However

mmm = 3000

? = 4000

This is where the standard system ends. The next level of symbols are disputed. The solution is either a line over or under the symbol, so

$\overline{v} = 5000$

$\underline{x} = 10,000$

However, mathematical calculation of such numbers don't really appear in the historical record and as such are hypothetical constructions, not important here. The focus, that is common to all mathematics, is a counting system - with a particular focus on the Chinese abacus.

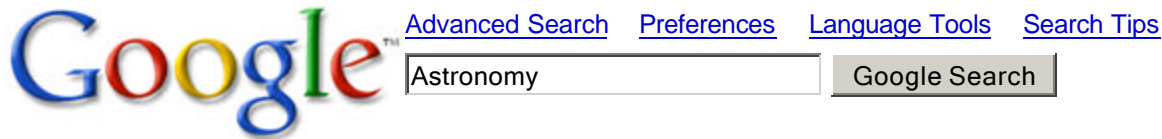
6. Featured Internet Resource Search Engines

This issue's featured internet resource is the much used and often overlooked search engine. If you're doing research on the internet, then the right search engine means everything. For those too young to remember the library, the library is

the best example of how to use the internet for research. The internet, like the library, is a research environment. In fact, it was the research environment, that used the library as it's main source of information, that developed the internet to share and store the information required for research. As such, the internet became the new library. Researchers understand this, and know that it does not specifically make research shorter or easier, but allows for access to more information. Traditionally, researchers had to wait for textbooks, books and publications to get information on a topic of research. Rather than use public library, research facilities built specialty library. As a result, a researcher working on a topic that crosses disciplines would have to travel to different libraries.

Irregardless of where the library was, they functioned the same. The list of material in the library was listed in a card catalogue. This catalogue was indexed alphabetically by title. Each card had the title, the author, the subject and a brief description of the book, periodical, or paper. Once you selected what you wanted (often a variety of books, periodicals, etc.) you would have to read through each item for the specific information that you wanted. Obviously this took hours and researchers often spent years in the library on their work. The internet changed that, because it brought the library to the desktop making research a little easier, but not less time consuming. However, when the internet was presented to the public, it was assumed that research time would be much shorter - information easier to find. This was, and is, not the case. More information means more time

understanding it - in the context of your own. So this issue's featured internet resource is the card catalogue of the internet - the search engine.



Web [Images](#) [Groups](#) [Directory](#) [News](#)

Searched the web for **Astronomy**.

Results **1 - 10** of about **7,400,000**. Search took **0.12** seconds.

Category: [Science > Astronomy > Personal Pages](#)

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Research Note

Newtonian Electrodynamics from General-Relativistic Arguments

FRANCO OCCHIONERO*

Institute for Space Studies, Goddard Space Flight Center, NASA, New York

Received July 23, 1970

In general relativity, a vacuum is electrically polarized in the presence of a magnetic field whenever the mixed components of the metric tensor do not vanish (which occurs in astronomy around a massive rotating object because of the dragging of the inertial frame). This note illustrates the phenomenon by making use of the fact that it does not require curvature and, hence, may occur in a *flat* space-time: In fact, in corotating coordinates the vacuum around a rotating, magnetic, newtonian star is electrically charged. By assuming near sphericity of the star and an external 2ⁿ-pole poloidal magnetic field, it is easy to evaluate the electrostatic potential, which reflects the existence of the fictitious charge density with a non-harmonic term proportional to $(1/r)^n P_{n+1}(\cos \theta)$. This note also establishes a convenient formalism for the treatment of the general-relativistic aspects of the same problem.

Key words: general relativity — electromagnetism

Schiff (1939) recognized that the very formulation of electrodynamics in rotating coordinates is a general-relativistic problem, even when the Riemann tensor vanishes (a similar conclusion can be inferred from Landau and Lifshitz 1962, p. 296). Although no need for such a formalism arises in the galilean space-time to be considered below and special-relativistic considerations suffice (see Goldreich and Julian, 1969 and the Appendix), the study of the fictitious charge (and current) densities arising with the adoption of rotating coordinates, in analogy to the Coriolis and centrifugal forces of mechanics, illustrates the nature of the virtual charges in a curved space (Occhionero, 1970).

Irvine (1964) clarifies the controversial problem of relating, in any metric $g_{\alpha\beta}$, the em tensor $F_{\alpha\beta}$ to the physical components of the em field, as actually measured by any specific observer: The ambiguities often met in the literature can be avoided only by using the observer's orthonormal tetrad, OT (Synge, 1960), which translates in mathematical terms the notion of a locally tangent inertial system of reference (here the locally corotating observer). With $x^0 = ct$ and space coordinates x^1, x^2 and x^3 , the OT, $\lambda_{(\mu)}^\alpha$, defines uniquely its observer's physical em fields

* NAS-NRC Senior Postdoctoral Associate on leave of absence from Laboratorio di Astrofisica, Frascati (Italy).

as follows:

$$\begin{aligned} F_{(\mu)(\nu)} &= \lambda_{(\mu)}^\alpha \lambda_{(\nu)}^\beta F_{\alpha\beta}, \\ E_{(k)} &= F_{(k)(0)}, \\ B_{(1)} &= F_{(2)(3)} \text{ and cyclic,} \end{aligned} \quad (1)$$

where Greek letters range from 0 to 3 and Latin from 1 to 3.

The poloidal, axially symmetric, stationary magnetic field of a rotating or non-rotating, newtonian or relativistic star is best studied in spherical polar coordinates,

$$x^1 = r, x^2 = \theta, x^3 = \phi, \quad (2)$$

from the generalized wave-equations for the vector potential, A_α ,

$$F_{\alpha\beta} = A_{\alpha,\beta} - A_{\beta,\alpha}. \quad (3)$$

Under time- and azimuth-independence, an obvious gauge is satisfied and the equations for A_0 and A_3 may be cast in the convenient form

$$\square A_W + 2 \sum_{N=1,2} g^{NN} \left\{ \frac{W}{WN} \right\} F_{NW} = 2 \sum_{N=1,2} g^{NN} \left\{ \frac{Z}{WN} \right\} \cdot F_{ZN} + (4\pi/c)j_W \quad W, Z = 0,3, W \neq Z, \quad (4)$$

$$\square = \frac{1}{\sqrt{-g}} \frac{\partial}{\partial x^\beta} \sqrt{-g} g^{\beta\gamma} \frac{\partial}{\partial x^\gamma}.$$

For a non-rotating, spherical and newtonian star,

$$g_{\alpha\beta} = \text{diag} (+1, -1, -r^2, -r^2 \sin^2\theta), \quad (5)$$

$$-A_{3,rr} - (1/r^2)\Lambda(A_3) = (4\pi/c)j_3, \quad (6)$$

$$\Lambda = \sin\theta \frac{\partial}{\partial\theta} \frac{1}{\sin\theta} \frac{\partial}{\partial\theta}. \quad (7)$$

The Λ -operator (which is not self-adjoint) has the following eigenfunctions (which are not orthogonal)

$$\Lambda\psi_n(\theta) + n(n+1)\psi_n(\theta) = 0,$$

$$\begin{aligned} \psi_n(\theta) &= \frac{1}{n(n+1)} \sin\theta \frac{d}{d\theta} P_n(\cos\theta) \\ &= \frac{1}{(2n+1)} [P_{n+1} - P_{n-1}]. \end{aligned} \quad (8)$$

They satisfy the relations

$$\begin{aligned} \cos\theta P_n + n\psi_n &= P_{n+1}, \\ \cos\theta P_n - (n+1)\psi_n &= P_{n-1}, \end{aligned} \quad (9)$$

and can be used to describe the 2^n -pole magnetic field. The latter must be continuous at the surface of the star and regular at its center: A current layer at $r = L < R$ satisfies these requirements in a schematic, but convenient way, since it makes Eq. (6) actually homogeneous and provides model-independent considerations (L disappears from the final results). The appropriate continuous solution of (6) is, then,

$$\begin{aligned} \text{for } 0 \leq r \leq L, A_3 &= BR^2(R/L)^{2n+1}(r/R)^{n+1}\psi_n(\theta), \\ \text{for } L \leq r, A_3 &= BR^2(R/r)^n\psi_n(\theta), \end{aligned} \quad (10)$$

where the chosen normalization makes equal to B the field on the poles, $r = R$, $\theta = 0$ and π . The OT of the observer at rest with respect to the coordinates is

$$\begin{aligned} \lambda^{\alpha}_{(0)} &= (1, 0, 0, 0), \lambda^{\alpha}_{(1)} = (0, 1, 0, 0), \\ \lambda^{\alpha}_{(2)} &= (0, 0, 1/r, 0), \lambda^{\alpha}_{(3)} = (0, 0, 0, 1/r\sin\theta), \end{aligned} \quad (11)$$

and operates in (1) as a set of geometrical scaling functions:

$$B_{(r)} = B(R/L)^{2n+1}(r/R)^{n-1}P_n, \quad (12)$$

for $0 \leq r < L$,

$$B_{(\theta)} = B(R/L)^{2n+1}(r/R)^{n-1} \frac{1}{n} \frac{dP_n}{d\theta},$$

$$B_{(r)} = B(R/r)^{n+2}P_n, \quad (13)$$

for $L < r$,

$$B_{(\theta)} = -B(R/r)^{n+2} \frac{1}{n+1} \frac{dP_n}{d\theta}.$$

Let now the star be imagined in slow rotation with uniform angular velocity Ω around the $\theta = 0$ axis, and let corotating coordinates be chosen

$$t' = t, r' = r, \theta' = \theta, \phi' = \phi - \Omega t. \quad (14)$$

By neglecting, for shortness, all the Ω^2 -corrections and, consistently, the rotational deformation of the star, the $g_{\alpha\beta}$'s retain the form (5) on the diagonal, but acquire a new off-diagonal element,

$$g'_{03} = -(\Omega/c)r^2\sin^2\theta, \quad (15)$$

which, in this formulation, couples electric and magnetic fields (Landau and Lifshitz, 1962; Occhionero, 1970). Primes will be omitted henceforth. The OT of the observer locally at rest with respect to these coordinates is

$$\begin{aligned} \mu^{\alpha}_{(0)} &= \lambda^{\alpha}_{(0)}, \mu^{\alpha}_{(1)} = \lambda^{\alpha}_{(1)}, \mu^{\alpha}_{(2)} = \lambda^{\alpha}_{(2)}, \\ \mu^{\alpha}_{(3)} &= \left(\frac{\Omega}{c} r \sin\theta, 0, 0, \frac{1}{r \sin\theta} \right), \end{aligned} \quad (16)$$

the λ 's being defined in (11). For the observer (16), the relation of the physical magnetic field to $F_{\alpha\beta}$ is the same as for (11) (aside from Ω^2 -corrections which imply a tangential discontinuity of B on the star surface and a fictitious surface current) and the equation for A_3 , (6), remains unchanged: Hence the magnetic field is given again by (12) and (13). The electric field is

$$E_{(r)} = F_{10}, E_{(\theta)} = F_{20}/r, E_{(\phi)} = F_{30}/r\sin\theta = 0, \quad (17)$$

so that its vanishing inside the conductor is equivalent to the constancy of A_0 therein. For $W = 0$, Eq. (14) yields

$$-\nabla^2 A_0 = -\frac{2\Omega}{cr^2} (rF_{31} + \cot\theta F_{32}) + 4\pi\rho, \quad (18)$$

the r.h.s. of which consists of the fictitious charge density (Schiff, 1939) and of the real polarization ρ ; only the latter vanishes outside the star under the present assumption of perfect vacuum. Inside, the necessary condition for the constancy of A_0 , is the vanishing of the r.h.s. of (18): Hence,

$$\begin{aligned} \rho &= -\frac{\Omega B}{2\pi c} (R/L)^{2n+1}(r/R)^{n-1}P_{n-1}(\cos\theta), \\ &\text{for } 0 \leq r < L, \end{aligned}$$

$$\rho = -\frac{\Omega B}{2\pi c} (R/r)^{n+2}P_{n+1}(\cos\theta), \text{ for } L < r < R. \quad (19)$$

The volume integral of ρ over the star vanishes for any $n > 1$, but for $n = 1$, there is a net charge inside the star,

$$Q = -\frac{2}{3}(\Omega BR^3/c), \quad (20)$$

even if the total charge of the star may still be zero, as in Goldreich and Julian (1969). For $r \geq R$ (with $\rho = 0$), the solution to (18) is the sum of an inhomogeneous integral and a harmonic function; the arbitrary constants are determined by the continuity of A_0 :

$$A_0 \equiv 0, \text{ for } r \leq R, \quad (21)$$

$$A_0 = \frac{\Omega BR^2}{(2n+1)c} [(R/r)^n - (R/r)^{n+2}] P_{n+1}(\cos\theta),$$

for $r \geq R$,

which proves the statement of the abstract. Finally, the surface charge density is

$$\sigma = -\frac{\Omega BR}{2\pi c(2n+1)} P_{n+1}(\cos\theta), \quad (22)$$

and integrates to zero for all n 's.

Appendix

Special relativistic considerations provide an alternative evaluation of (21): The OT of the fixed observer is $\lambda_{(\mu)}^x$ of (11), and the OT of the locally corotating observer, as viewed from the non-rotating coordinates, is

$$v_{(0)}^x = (1, 0, 0, \Omega/c), \quad v_{(k)}^x = \mu_{(k)}^x, \quad (A1)$$

with the μ 's of (16). The relation between the em fields measured by the two observers can be worked out from (1) (Irvine, 1964) and is, of course, a Lorentz transformation (exact when the γ 's are inserted),

$$\mathbf{E}(v) = \mathbf{E}(\lambda) + 1/c (\boldsymbol{\Omega} \times \mathbf{r}) \times \mathbf{B}(\lambda), \quad (A2)$$

$$\mathbf{B}(v) = \mathbf{B}(\lambda). \quad (A2)$$

Internally, $\mathbf{E}(v) \equiv 0$ (Goldreich and Julian, 1969), and the expressions (19) and (20) are immediately derived from

$$\nabla \cdot \mathbf{E} = -2\boldsymbol{\Omega} \cdot \mathbf{B} + (\boldsymbol{\Omega} \times \mathbf{r}) \cdot \nabla \times \mathbf{B},$$

Externally, $\mathbf{E}(\lambda)$ is the gradient of a harmonic function, but $\mathbf{E}(v)$ is not, because of (A2):

$$\mathbf{E}(\lambda) = \sum_{s=0}^{\infty} K_s \nabla [(R/r)^{s+1} P_s(\cos\theta)], \quad (A3)$$

$$1/c (\boldsymbol{\Omega} \times \mathbf{r}) \times \mathbf{B} = \frac{\Omega BR^2}{(2n+1)c} \nabla [(R/r)^n (P_{n-1} - P_{n+1})]. \quad (A4)$$

The constants in (A3) ($K_0 = 0$ in Goldreich and Julian, 1969) are determined from

$$E_{(\theta)}(v) = 0 \text{ at } r = R. \quad (A5)$$

This gives

$$K_s = 0 \text{ for } s \neq n-1, n+1,$$

$$K_{n+1} = -K_{n-1} = \frac{\Omega BR^2}{(2n+1)c},$$

$$\mathbf{E}(v) = -\nabla \Phi,$$

$$\Phi = \frac{\Omega BR^2}{(2n+1)c} [(R/r)^n - (R/r)^{n+2}] P_{n+1}(\cos\theta),$$

in agreement with (21).

Acknowledgements. I am deeply indebted to Dr. P. Goldreich for illuminating discussions and to Dr. R. Jastrow for hospitality at the Institute for Space Studies.

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F. Occhionero
 Laboratorio di Astrofisica
 C. P. 67
 00044 Frascati, Roma, Italy

Disruption of Star Clusters Through Passing Interstellar Clouds Investigated by Numerical Experiments

P. BOUVIER and G. JANIN
Geneva Observatory

Received September 18, 1970

The stochastic tidal effect of interstellar clouds passing near a star cluster causes the latter to expand and disintegrate. The problem, already tackled by Spitzer (1958), is taken up anew with the help of numerical experiments performed on a model of the cluster and of the clouds. The results point out to the importance of the interstellar passing clouds with respect to the disintegration of a small stellar cluster; in particular, a cluster of 25 stars should disrupt in less than half a billion years.

The galactic tidal field was not included in this paper.

Key words: stellar dynamics — star cluster — interstellar cloud — disruption

Introduction

External causes for the gradual disintegration of a stellar cluster lie essentially in tidal action from the galactic field and also, in the case of open clusters, from passing clouds of interstellar matter.

The galactic tidal effect was investigated first by Bok (1934) who showed that, in order to be stable, a stellar cluster should keep its mean mass density above a certain critical value ρ_c and that incipient instability will manifest itself first along the line joining the cluster to the galactic centre. Recently Hayli (1970) investigated the same problem by means of numerical experiments and pointed out the very active role played by the galactic field in the process of evaporation of stars from an open cluster orbiting in the galactic plane. The lifetime of the cluster did not appear however to be appreciably shortened through such an interaction.

Tidal effect induced by a massive elongated cloud of gas has been studied by Bouvier (1958a) with the result that, in favourable situations, the critical mean density ρ_c of the cluster might be increased by nearly a whole order of magnitude and that here too, a preferential direction may be defined for incipient instability.

A somewhat more realistic picture for the tidal effect of interstellar clouds on a stellar cluster consists in the cumulative action of encounters undergone by the cluster with rapidly passing clouds. The total energy of the cluster shall increase during this

process, from its initially negative value up to zero when the cluster will cease to exist as a single gravitationally bound system. This final state will be reached in a finite duration time, called “disruption time” by Spitzer who proceeded to its evaluation in a first attempt on the problem (1958).

Spitzer's Analysis

The calculation of the disruption time was carried out under the condition of “impulsive approximation”, i.e. assuming the duration time of the encounter between cloud and cluster to be much less than the mean period of the stellar motions within the cluster.

The rate of energy increase of the cluster is then given by

$$\frac{dE}{dt} = \frac{8\pi G^2 M R^2}{3V} \int_0^\infty n(M_n) M_n^2 dM_n \int_{R_c}^\infty \frac{dp}{p^3} \quad (1)$$

where M is the cluster's mass, R its radius, $n(M_n) dM_n$ the number of clouds having masses in the range $(M_n, M_n + dM_n)$, V the average velocity of the clouds relative to the cluster, R_c a lower limit for the impact parameters p .

The cluster radius R can be related to the energy E by the virial theorem and, assuming further an optical extinction per cloud independent of the cloud size, Spitzer finds a disruption time which we write here in the case where all the clouds have same mass

M_n and radius R_n

$$t_a = \frac{1}{16\pi G} \frac{V \varrho R_c^2}{n M_n \varrho_n R_n^2} \quad (2)$$

where ϱ_n is the mass density inside any cloud, ϱ the initial mean mass density of the stellar cluster and n the number density of clouds in space.

If the impulsive approximation were not valid, a somewhat rough analysis by Spitzer shows that the energy exchange during one encounter increases slightly when the encounter time is comparable to the mean oscillation period of the stars and drops markedly for any further increase of the encounter time. In the cases which we shall have to deal with later, the condition of impulsive approximation is always realized.

Estimates of the cloud masses have varied widely since 1958 and more recent determinations of the observational data have led to enhance the value of t_a by a whole order of magnitude, thus rendering it very often larger than the cluster's lifetime against all other disintegration causes (K. H. Schmidt, 1962).

In the Eqs. (1) and (2), Spitzer had chosen $R_c = R_n$, neglecting therefore encounters so close that the cluster will pass through the cloud; according to (2), smaller values of R_c would lower t_a , but we must bear in mind that (1) and (2) rest upon the usual approximate expressions of the tidal force, valid when R_c remains much larger than the cluster radius R .

Standard Models for the Cluster and the Clouds

We now investigate the closer encounters with the help of numerical experiments; it will turn out that these encounters are of paramount importance for the disruption of the cluster by the passing clouds. Nevertheless, (2) will be useful to estimate the effect of distant encounters.

The first thing we have to do is to define a standard cluster model and a few standard cloud models.

Our standard cluster contains 25 stars, a rather modest number which will enable us to carry out several runs in a reasonable computing time. The initial state of the cluster is taken as one of uniform distribution in position and velocity spaces; the cluster is spherical with a radius of 2 pc, in agreement with observational data on several small galactic clusters (Allen, 1962, p. 262).

It is worth noting here that in a comparative study of expansion versus contraction in the evolution of a star cluster, King (1958) had drawn a diagram

illustrating the possible evolutionary tracks and isochrones in terms of the radius R and the total number N of stars in the cluster. Our standard representative point $N = 25$, $R = 2$ does fall in the expansive region, where the subsequent evolution is dominated by the tidal encounters with interstellar clouds.

The maximum initial stellar speed is fixed by the virial theorem, assumed to hold in order to ascribe most of the dynamical evolution of the cluster to the tidal action of the clouds.

Moreover, the cluster stars are given a mass spectrum proportional to m^{-2} (Jaschek and Jaschek, 1957). The ratio of the smaller to the larger mass is 1:10 and the mean value equal to one solar mass.

With regard to the standard clouds, the latest observational data (Allen, 1962; Kaplan, 1966; Te-raulti, 1963; Landolt-Börnstein, 1965; Spitzer, 1968; Stone, 1970) have incited us to discriminate three types of clouds, respectively the light clouds of mass $50 M_\odot$, the intermediate clouds of $200 M_\odot$ and the heavy ones having a mass of $500 M_\odot$ (Table 1). All of them are considered as spherical homogeneous clouds of common mass density $0.25 M_\odot \text{pc}^{-3}$ and the clouds are distributed in space at an overall concentration of 40 clouds per million cubic parsec.

Table 1

Cloud	Mass (M_\odot)	Radius (pc)	Velocity (km/s)
Light	50	3.6	14.0
Intermediate	200	5.8	7.0
Heavy	500	7.8	4.4

The velocities of these clouds are random in direction and their values are determined here by postulating energy equipartition. The latter assumption is not justified, we adopted it for the sake of simplicity; in spite of a weak tendency of the smaller clouds to have larger velocities, the true distribution is unknown but seems to deviate somewhat from energy equipartition (Penston *et al.*, 1969). Anyhow, the system of the clouds appears to possess a much larger kinetic energy than the stellar cluster so that we cannot just treat the cluster possessing N stars interacting between themselves and also with N' clouds as a single $(N + N')$ -body bound system. We have to consider a sphere of radius R_c around the cluster's centre and select a number of clouds

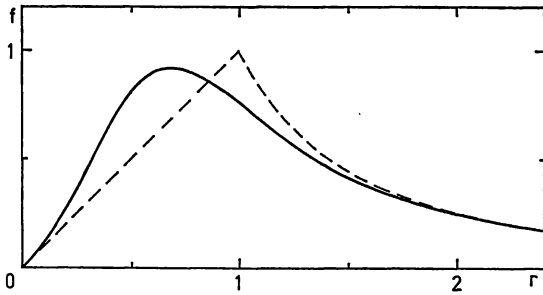


Fig. 1. Force per unit mass due to a cloud of unit radius and mass. The dashed line corresponds to the homogeneous model

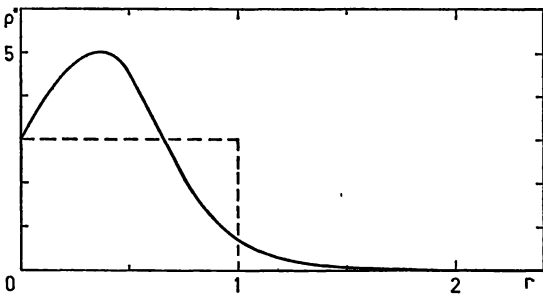


Fig. 2. Mass density $\rho^*(r) = 4\pi\rho(r)$ of a cloud of unit mass and radius ($G = 1$). The dashed line corresponds to the homogeneous model

within that sphere such as to simulate and maintain around the cluster the observed mean concentration of interstellar clouds in space.

The numerical integration method applied here is that of Nordsieck (Janin, 1970); it is a multistep method of the predictor-corrector type which implies that to obtain values at the n -th step, we need to know the values computed at former steps and this requires the computed functions to be continuous and their derivatives as well, at least up to the fifth order. Now if a cluster star penetrates into a spherical homogeneous cloud of radius R_n , as it will occur in a close encounter between cloud and cluster, then the force derivative will be discontinuous across R_n and we thus have to replace the crude model of a homogeneous sphere by a spherical distribution giving smoothed out field and density distributions. Such a procedure amounts to the substitution of a spherical distribution of matter or "hazy edge" cloud (Bouvier, 1958b) to the "sharp edge" cloud with a well defined radius. Instead of a force increasing as r inside and decreasing like r^{-2} outside the spherical cloud of mass M and radius R , we therefore used here the continuous interpolating

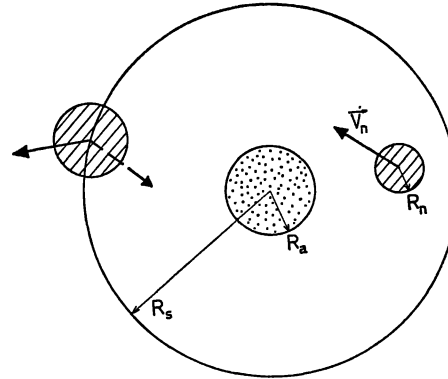


Fig. 3. Sphere of random reflection (radius R_s) concentric to the star cluster (radius R_a), containing clouds of radius R_n and velocity V_n

rational expression

$$f(r) = GM \frac{Rr + 2r^2}{R^4 + Rr^2 + 2r^4} \quad (3)$$

where R now defines the radius of the sphere containing the mass $\frac{3}{4}M$. Figs. 1 and 2 show the force per unit mass $f(r)$ and the mass density $\rho(r)$ which produces it, dropping rapidly to zero when r exceeds about $1.5R$.

The Sphere of Random Reflection

In order to maintain a constant cloud concentration around the cluster, we follow the motion of each cloud located within the sphere of radius R_s , up to the point where it reaches the surface of that sphere; we then randomly redistribute the velocity direction so as to send the cloud back into the sphere (Fig. 3).

Such a "random reflection" of the cloud will produce a slight but rapid variation of the velocity components and consequently of the force exerted by the cloud on the cluster stars. If we had considered the N' clouds on the same footing as the N stars, viz. as members of a $(N + N')$ -body system, the (rather cumbersome) starting procedure of the Nordsieck integration method should be applied to the motion of a cloud after every contact with the random reflection sphere.

In a preliminary series of experiments performed in such conditions it turned out that, thanks to its great stability, the Nordsieck method proved to be perfectly capable of overcoming the incipient instabilities due to the random reflections. In order to

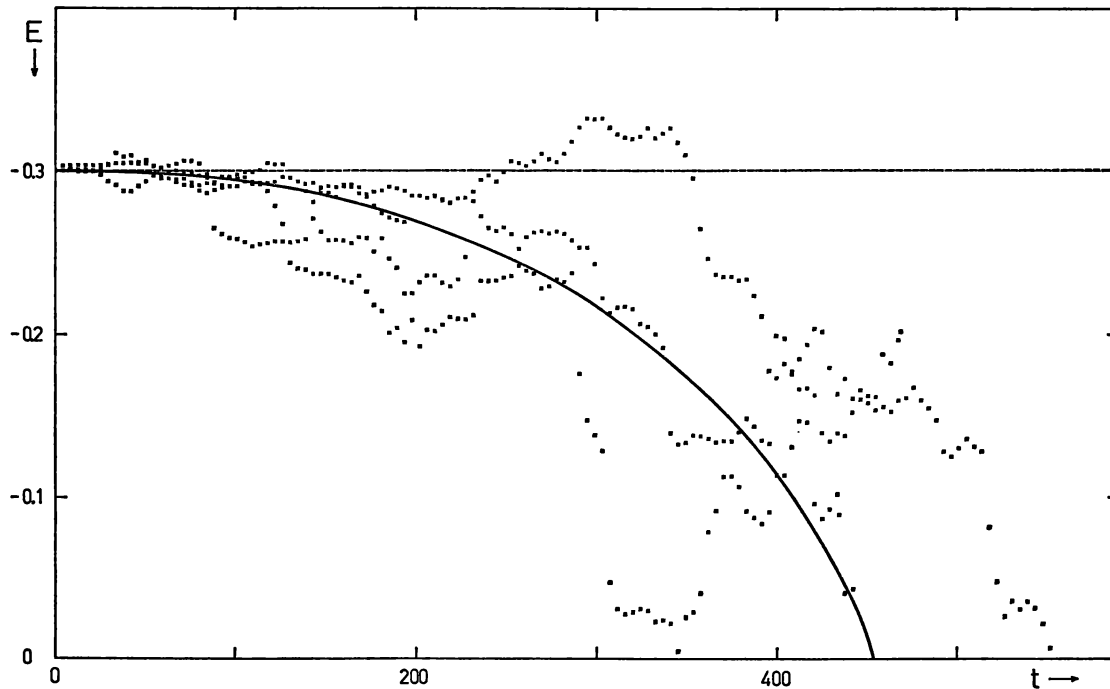


Fig. 4. Total energy increase of the star cluster in function of time for 4 numerical experiments. The curve represents an estimated regression line for the different runs and the horizontal dashed line corresponds to the initial energy

simplify the procedure, we left the clouds to describe rectilinear trajectories with the corresponding velocities of Table 1, between any two successive random reflections, but we had to give up the check on the constancy of the total energy inside the sphere of random reflection. How are we to choose its radius R_s ?

Experiments were carried out with a number of clouds varying from 1 to 9; with 3 or 4 clouds, the effect is a little more conspicuous as it is with one cloud only but taking 9 clouds does not bring any significant additional contribution as compared to the case of 3 or 4 clouds. We therefore retain three clouds as sufficiently representative of the close encounters effect and choose one cloud of each of the three types previously defined (Table 1). R_s is then given by

$$\frac{4\pi}{3} R_s^3 n = 3$$

and with $n = 4 \times 10^{-5} \text{ pc}^{-3}$, we find $R = 26 \text{ pc}$.

Numerical Results. Final Remarks

Four runs were carried out on the CDC 3800 computer of the Geneva University, with different initial position and velocity coordinates for the

stars and the clouds. The initial value of the total energy of the cluster was equal to -0.3 in units chosen such that G , the total mass and the initial radius of the cluster be equal to unity. In spite of rather large fluctuations from one run to another, it appeared clearly (Fig. 4) that the cluster's total energy increased at first slowly then much quicker as the cluster expanded.

The cluster actually disintegrates into several bound subsystems showing a decreasing mutual binding energy leading to an irregular form of the cluster.

Since the increasing total energy of the cluster was always computed by retaining all the 25 stars, these which had escaped from the cluster as well as those belonging to a tightly bound subsystem, it becomes difficult to define a disruption time unambiguously. We may only state that in our present standard problem, the total energy of the cluster becomes zero over a time scale of 450 million years (with a cloud concentration of $4 \times 10^{-5} \text{ pc}^{-3}$); after that time, the cluster has lost its unity, having broken away into independent subsystems.

During the same span of 450 million years, the total energy of the standard cluster, left to evolve

on its own as an isolated cluster, remained constant to an accuracy of less than 1 part in 1000. Comparison with the present increase of 0.3 clearly shows that the tidal influence of close encounters with interstellar clouds is beyond doubt of importance.

The Spitzer formula (2) with $R_c = R_n = 5.73$ pc should have led us to a disruption time of 1.9×10^9 yr; that is about 4 times our present value. This shows the importance of encounters occurring with $R_c < R_n$. On the other hand, the disruption time obtained by making $R_c = R_s = 26$ pc in formula (2) amounts to 4×10^{10} yr; the influence of distant cloud encounters is therefore negligible.

The situation bears some resemblance with the one prevailing for the evaporation process where the cumulated effect of distant stellar encounters is unable to produce the escape of a particular star from the cluster while only close encounters may give rise to a star endowed with positive energy. In the present problem also, the energy increase of a cluster is due essentially to close encounters with passing clouds.

Furthermore the detailed evolution of our standard cluster considered first as isolated and then with the introduction of the three perturbing clouds (as pictured on a movie) reveals a certain inhibition to the formation of the central density cusp and to the evaporation rate when the clouds are present.

Lastly, let us recall that the present investigation, carried out in conditions similar to those postulated

by Spitzer, neglects the influence of the galactic tidal field. A more realistic approach should include both the stochastic effect of passing clouds and the continuous action of the galactic field.

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P. Bouvier
G. Janin
Observatoire de Genève
1290 Sauverny, Switzerland

Subject: [api_apis] Astrobot Diaries:Biff on Mars

Date: Thu, 08 Jan 2004 15:32:45 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY

Astrobot Diaries: ENTRY NO. 23
2004 Jan. 5: First Astrobot on Mars

UPDATE: BIFF STARLING HAS LANDED SAFELY ON MARS!

Read his first diary from Mars at:
<http://redrovergoestomars.org/astrobots/d23.html>

Can You Crack the Secret Mars Code?
A Planetary Society produced mini-DVD is mounted to Spirit's lander petals. An image was taken shortly after the rover landed on Mars. Clearly visible around the rim of the DVD is a message, written in a secret code of dots and lines.

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https://planetary.org/redrover-dvd/dvd_spirit.html

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Subject: [api_apis] Astrobot Diaries: Sandy on Mars!

Date: Mon, 26 Jan 2004 17:09:10 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY
NEW ASTROBOT DIARIES

NO. 29: 2004 Jan 25: SANDY MOONDUST SAFE ON MARS!
Sandy is safe on Mars, and she is really excited; so much so that it is affecting her speech. See first images, ready first haiku, and experience Sandy gone surfer?

<http://www.planetary.org/rrgtm/astrobots/d29.html>

NO. 28: 2004 Jan 24: SANDY READY FOR LANDING
Sandy is ready for landing and even debuts another emotion packed haiku, while Sandy and Biff discuss why their landing sites were chosen and why their look different.

<http://www.planetary.org/rrgtm/astrobots/d28.html>

NO. 27: 2004 Jan 20: STRETCH YOUR ARM OUT
Up Close and Personal with Mars Spirit's robotic arm reaches out for the first time, and Biff gets a taste of Mars.

<http://www.planetary.org/rrgtm/astrobots/d27.html>

NO. 26: 2004 Jan 16: DRIVING OFF THE LANDER
Biff recounts the rotation of the rover on the lander, followed by its drive off the lander. Biff smiles for the camera again, and the gang says hi to the Student Astronauts.

<http://www.planetary.org/rrgtm/astrobots/d26.html>

NO. 25: 2004 Jan 11: PYROS AND SECRET CODES
Biff learns about wheel stretching and those popping noises he's been hearing. He also learns his home won't get run over. And, he challenges the world to decode a secret message from him.

<http://www.planetary.org/rrgtm/astrobots/d25.html>

Subject: [api_apis] Next Issue of the eJournal & New Features for Vol.1 2004

Date: Thu, 29 Jan 2004 05:03:19 -0500

From: Astronomy & Physics Internet Society <orionm42@api-apis.org>

Reply-To: api_apis@yahoogroups.com

Organization: A Free & Open Society

To: api_apis@yahoogroups.com

New Features for Vol.1 2004

The next issue of the eJournal will come out in the last week of February and will be a two month issue - Jan/Feb 2004. Bi-monthly issues will be used to develop new features for Vol.1 2004. Features will either be permanent or special to this volume.

Current Features

1. Main Article
2. Introduction to Astronomy
3. Introduction to Physics
4. Introduction to Mathematics
5. Featured Internet Resource
6. Featured Research Article
7. Monthly Posts

New Features Currently Under Development for 2004

1. Book Study - to become feature # 2 (2 moves to 3, etc.)
 - a. Book - Flat & Curved Space Time;
 - i. Chapter(s) # 1,2 - issue Jan/Feb
 - ii. Chapter (s) # 3 - issue Mar
 - iii. Chapter (s) # 4,5 - issue Apr
 - iv. Chapter (s) # 6,7 - issue May
 - b. Book - The Cosmic Code: Quantum Physics as the Language of Nature
 - i. Part # 1 - sec. 1,2 - issue Jun/July
 - ii. P.1 - sec. 3-7 - issue Aug
 - iii. P.1 - sec. 8-13 - issue Sept
 - iv. P.2 - sec. 1-6 - issue Oct
 - v. P.2 - sec 7-12- issue Nov
 - vi. P.3 - secc all - issue Dec
2. NASA and the history of Flight - Special feature (# 6 - 6 becomes 7)
 - i. Developments between 1907 to 1917 - Mar
 - ii. Developments between 1917 to 1927 - Apr
 - iii. Developments between 1927 to 1937 - May
 - iv. Developments between 1937 to 1947 - Jun/July
 - v. Developments between 1947 to 1957 - Aug
 - vi. Developments between 1957 to 1967 - Sept

3. Science Museum walk through - May issue (special/tenative)
4. Regent Review & SAT Study on-line - Jun/July issue
(permanent/tenative)
5. Lab workshop - Aug issue (permanent/tenative)

6. Letters to the editor will be taken from group posts
(mailto:api_apis@yahoogroups.com) - permanent

A note to teachers, you can use this journal and our website to develop and maintain your science knowledge. Further, you may take (develop) course material directly from here.

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Thank You

Dr. Daniel Carras

Astronomy & Physics Internet Society

<http://api-apis.org>

<mailto:info@api-apis.org>

"An open society that Rich Feynman would be happy with!"

Dr.Dan Iam with Green Eggs and Ham [Ref Dr. Seuss]

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To unsubscribe from this group, send an email to:

api_apis-unsubscribe@yahoogroups.com

Your use of Yahoo! Groups is subject to:

<http://docs.yahoo.com/info/terms/>

Subject: [api_apis] Astrobot Diaries: Opportunity Drives Off

Date: Wed, 4 Feb 2004 14:40:49 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY

Astrobot Diary 30

Jan 30, 2004: Opportunity Drives Off...Over Sandy?
The Opportunity rover successfully drives off the lander,
but the DVD and maybe Sandy are right in the path of
the metal wheels.

Did our intrepid explorer and the four million
names she guards survive?

Read more at:

<http://planetary.org/rrgtm/astrobots/d30.html>

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<https://planetary.org/JoinUs.html>

For more information on The Planetary Society's
Red Rover Goes to Mars project go to:

<http://redrovergoestomars.org>

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Yahoo! Groups Links

Subject: [api_apis] Astrobot Diaries: Spirit Working Great

Date: Mon, 09 Feb 2004 16:41:07 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY

Astrobot Diary 31
2004 Feb 02: SPIRIT WORKING GREAT

Spirit is almost back to full health after several days of computer issues. Biff tells of mountain climbing, and science analyses continue of his "mountain" rock, Adirondack.

<http://planetary.org/rrgtm/astrobots/d31.html>

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<*> To visit your group on the web, go to:
http://groups.yahoo.com/group/api_apis/

Subject: [api_apis] Astrobot Diaries: Sandy's World View Changes

Date: Fri, 13 Feb 2004 11:33:06 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY

Astrobot Diary NO. 32
2004 Feb 09: Sandy's World View Changes

After having been run over by the rover, Sandy is putting more emphasis on appreciating beauty and taking the time to smell the hematite. Biff is completely weirded out by Sandy's behavior.

Read more at:
<http://planetary.org/rrgtm/astrobots/d32.html>

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Subject: [api_apis] Astrobot Diaries: Where on Mars is Biff Starling?

Date: Wed, 18 Feb 2004 13:35:30 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoogroups.com

To: "RedRover" <redrover@lists.planetary.org>

RED ROVER GOES TO MARS
ASTROBOT CORPS MEDIA ADVISORY

Astrobot Diary NO. 33
2004 Feb 17: Where on Mars is Biff Starling?

Where is Biff on Mars? Learn the answer as Biff learns from Jill Dot. Also, learn where he and the Spirit rover are going.

Read more at:
<http://planetary.org/rrgtm/astrobots/d33.html>

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Yahoo! Groups Links

Subject: [api_apis] Newsletter: Moon to Mars, Secret Code, New Advisor - February '04

Date: Fri, 05 Mar 2004 16:45:56 -0800

From: The Planetary Society <tps.mbl@planetary.org>

Reply-To: api_apis@yahoo.com

To: "Planetary Society" <planetarysociety@lists.planetary.org>

THE PLANETARY SOCIETY NEWSLETTER
February 2004

IN THIS ISSUE:

- "Lord of the Rings" Actor Added to Advisory Council
 - Taking Action! Write to the "Moon to Mars" Commission
 - Final Days to Crack the Secret Code on Mars
 - Watch Time Pass on Mars!
 - News! Water, Rosetta, Asteroids, Cassini, New Planetoid
 - Join The Planetary Society!
-

"LORD OF THE RINGS" ACTOR JOINS OUR ADVISORY COUNCIL

Acclaimed Welsh actor John Rhys-Davies has joined The Planetary Society's Advisory Council as its newest member.

Referencing both his role as the dwarf warrior Gimli in the "Lord of the Rings" and Isaac Newton's quote about standing on the shoulders of giants, Rhys-Davies quipped

upon accepting the position, "If you wish to see further than most, is it wise to stand on the shoulders of dwarves?"

Read more at:

<http://planetary.org/news/2004/rhys-davies.html>

WRITE TO THE PRESIDENTIAL "MOON TO MARS" COMMISSION

The Planetary Society is urging our members and supporters to send comments to the new Presidential "Moon to Mars" Commission citing the strong need for a program of robotic and human missions that makes steady, continuous progress towards sending humans to Mars. "The Commission needs to understand that public interest in the exploration of other worlds is high -- not just in the United States, but everywhere on Earth" said Louis Friedman, Executive Director of The Planetary Society. "This is one of the great enterprises of our civilization."

To find out more and write the commission go to:

http://planetary.org/news/2004/mtm_commission.html

You can read the Executive Director's entire statement at:

http://www.planetary.org/human/ldf_statement.html

LAST CHANCE TO CRACK THE SECRET MARTIAN CODE

Since the twin Mars Exploration Rover spacecrafts landed on Mars, puzzle-lovers around the world have been cracking the code on a Planetary Society and LEGO Company mini-DVD mounted on Spirit and Opportunity. Don't miss your chance to solve this Martian mystery.

To crack the code on Opportunity go to:

https://planetary.org/redrover-dvd/dvd_opportunity.html

To crack the code on Spirit go to:

https://planetary.org/redrover-dvd/dvd_spirit.html

MARSDIAL: THE MOVIE

WATCH TIME PASS ON MARS!

Watch time pass on Mars in new movies of a Mars-based sundial, the MarsDial, made from still images captured over a 10 day period by the Spirit rover. The movies were created by The Planetary Society's Student Astronauts, teenaged members of the Mars Exploration Rover team.

MarsDial movies are a product of our Red Rover Goes to Mars project.

View the movie at:

<http://redrovergoestomars.org/marsdial>

Learn more about our Student Astronauts at:

<http://www.redrovergoestomars.org/studast.html>

THIS MONTH'S PLANETARY HEADLINES

WATER, ROSETTA, ASTEROIDS, CASSINI, AND A NEW PLANETOID

Keep up with Planetary News at The Planetary Society website.

Mars Exploration Rovers Update:

Opportunity Finds Evidence for Past Liquid Water on Mars

http://planetary.org/news/2004/mer-update_3-02-04.html

Rosetta Launch: ESA's Comet Chaser Lifts-Off,
Begins 4.4 Billion-Mile Trek to Comet

http://planetary.org/news/2004/rosetta_launches.html

What to Do When the Big One Heads Our Way?

Apparent Close Call by Asteroid Stirrs Debate

http://planetary.org/news/2004/neo_debate.html

Cassini Captures Stunning Image of Saturn

http://planetary.org/news/2004/cassini_saturn.html

Giant "Planetoid" Detected at Edge of Solar System
Object Likely Largest Found since Pluto

<http://planetary.org/news/2004/2004dw.html>

JOIN THE PLANETARY SOCIETY
AS A MEMBER OF THE PLANETARY SOCIETY,
YOU ARE AT THE CENTER OF SPACE EXPLORATION!

Our members help shape the future of
space exploration - in advocacy campaigns,
at community events, and with special projects.

This is a great time to join and be a part of the
exploration of Mars, the search for extraterrestrial
intelligence, the discovery of near-Earth objects and
extra-solar planets, robotic missions to outer planets,
and the understanding of planet Earth. It is also a
critical time for deciding the future of human
exploration beyond Earth.

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