February 29, 1972 466-9234

THE PRAIRIE ASTRONOMER

Meeting Announcement

On Tuesday, February 29, we will meet in the Olin Hall of Science on the Nebraska Wesleyan Campus at 7:30. The program will feature slides taken of the lunar eclipse observed earlier this month, and a session on selecting a telescope. In addition we will have a number of other features and, of course, anything any member wishes to bring up will be discussed. Naturally we will have refreshments.

At our last meeting Larry Stepp, Dr. Gardner, and John Johnson brought slides. In addition we saw a film on the Hale observatory and the construction of the 200-inch telescope.

Occultation

At about 5:06 a.m. C.S.T. on the morning of March 8, the moon will pass tangent to a 7.6 magnitude star. This event will be visible only over a very narrow strip, but those in certain parts of Lincoln will be able to see something which could be quite spectacular as well as scientifically useful.

Through Lincoln the line starts around the air base in North-west Lincoln, enters the town between the university's downtown campus and the state fairgrounds and then proceeds to the South-east. The line crosses "O" Street at around 33rd, proceeds through Piedmont, then to Robert's Park, and finally out into the country towards Chaney. Anyone living within a mile or so of this line will be able to witness several events, that is, disappearances and reappearances behind the moon's limb's mountains and valley's. At the meeting I will bring a map showing where the line goes exactly.

The moon itself will be just slightly passed third quarter at 48% sunlit. The graze will occur on the dark side of the moon's disk. The moon will be at an altitude of 18° and an azimuth of 159°. The sun will still be 20° below the horizon.

For those in the club who have never seen a graze, this will be a good first experience. For the rest of us it will be a chance to observe one near home.

Anyone who took pictures of the lunar eclipse this month is asked to bring them to the meeting.

The magazines ordered last month--Modern Astronomy--have arrived, and they will be sold at the meeting.

In this newsletter, I am beginning a series of articles on technical subjects. Comments and questions on technical subjects are sought. It is my hope that this column may become a permanent feature of the newsletter.

Please note that a typing error has been made; equation (5) should end with the term:

$$d^2b/dt^2 \ r \sin a$$

instead of

$$(db/dt)^2 \ r \sin a$$

All results derived from equation (5) are right as far as I know.

For Sale: Six-inch reflector tube assembly. Phil Kelton, 434-0304.

Donn Baker, the club librarian, informs me that the following have been added to the library. Anyone interested in borrowing these or in donating to the library is advised to contact Donn.

Stars by Zim Baker
Insight into Astronomy by Leo Mattersdorf
Other Worlds than Ours by Richard A. Proctor

Observing in March

During the winter months many observers are yearning for the warm summer nights with the Milky-Way stretching overhead. However, February and March have their Milky-Way too. If the area just west of Canis Major is inspected with a telescope, the observer will note the field literally swarming with faint compacted stars. This faint cloud can be observed rising from the southern horizon in Puppis and continuing on upward between Canis Minor and Orion. It doesn't stop there, but keeps on going through southern Gemini, Auriga and Perseus where it finally dissipates and dives to the northwest horizon. Actually these stars are in the Milky-Way; we're just looking at the other half of the summer Milky-Way.

Anyway there are some very beautiful star clusters in the "other" Milky-Way. One of these is M-46, a very rich and condensed cluster containing many dim stars. I recommend for this cluster dark skies and averted vision, then you'll see about twice as many stars. While looking at M-46, try to locate NGC 2438, a faint planetary nebula on the northern edge of M-46. It looks like the Ring Nebula but is half as large and about two magnitudes fainter. Finding M-46 is easy, locate the brilliant star Sirius in your finder and move north towards ~~Polaris~~ until Sirius is at the south edge of the field. Then move straight east 15 degrees (about 4 finder fields) until you come to a fuzzy spot. This is M-47, a much brighter and larger cluster that is one degree west of ninth magnitude M-46. Incidently M-47 is one of the lost objects in the Messier catalogue, three of them were plotted wrongly and later found (M-47 is one of these); the other three have never been found, they were either comets or unresolved stars. In some star atlases M-47 is listed 38VIII in Herschel's Catalogue, which means it was the 38th object in the catagoric coarsely scattered clusters of stars. If a telescope is not at hand at least sweep this beautiful area with a pair of binoculars for there are many bright clusters scattered around.

Another fine cluster in winter skies is M-35, a large, bright cluster in the foot of Gemini. It is about magnitude six, and stretches over half a degree in area; again, use dark skies and averted vision to appreciate it. On the southern edge of M-35 is a small, very faint cluster that needs high power to resolve it. It looks like an eleventh magnitude object and may escape detection in a hasty sweep. Locate Eta Gemini in your finder and move about half a field north and west and M-35 will be seen easily.

A galaxy I have often read about, NGC 2903, is supposedly a double galaxy. Norton's Star Atlas shows it as two galaxies and several observers, including John Herschel, reported seeing a faint extension that somewhat resembled M-51. About a week ago I viewed this galaxy and saw what seemed to be a very small extension but nothing like the drawing and descriptions I've seen and heard. NGC 2903 is about magnitude nine and is easily found by going one degree south of 4.5 magnitude Lambda Leonis, which is just off the tip of Leo's sickle. It would be interesting if some members would view this galaxy and report what they see.

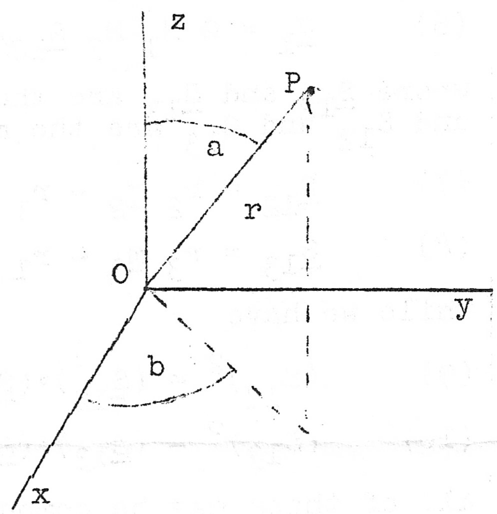
Brian Rugg

Several current magazines contain articles of interest to amateur astronomers. The following are available at the public libraries:

Aviation Week & Space Technology, Feb. 7, 1972. Reports on the joint U.S.-U.S.S.R. manned space effort; and the emerging data on Mars 3.

Scientific American, Feb. 1972, p. 72. "Intercontinental Radio Astronomy" by K.I. Kellermann.

Topics in Celestial Mechanics--I The three-body problem



In many problems it is desirable to be able to describe the motions of three isolated bodies under the influence of their mutual gravitational attractions. Among these are triple star systems, solar system configurations, and space travel. In what follows I will derive the differential equations describing the exact motion, and in future months I will discuss applications.

I will assume the reader is familiar with the rudiments of mechanics in a gravitational field, as well as vector algebra. The differential calculus will, of course, be used extensively.

As a beginning, note the figure to the right in which point P is defined by a distance r, a zeneth angle a, and an azimuthal angle b, all with respect to an origin O. Then, with $\underline{i}$, $\underline{j}$, and $\underline{k}$ unit vectors in the x-, y-, and z-directions respectively, we may define at P three vectors by the equations:

(1) $\underline{m} = \underline{i} \sin a \cos b + \underline{j} \sin a \sin b + \underline{k} \cos a$

(2) $\underline{n} = \underline{i} \cos a \cos b + \underline{j} \cos a \sin b - \underline{k} \sin a$

(3) $\underline{p} = -\underline{i} \sin b \qquad + \underline{j} \cos b$

It may be noted that $\underline{m}$, $\underline{n}$, and $\underline{p}$ are unit vectors and are mutually orthogonal. In addition, note that $\underline{m}$ is a radial vector. From this last it follows that if we let $\underline{r}$ be the position vector from P and r is the magnitude of $\underline{r}$, then

(4) $\underline{r} = r\, \underline{m}$

As it is, we are interested in the second derivative of $\underline{r}$. Hence from equation (4) we can determine

(5)
$$d^2\underline{r}/dt^2 = \underline{m} \left[d^2r/dt^2 - r\,(da/dt)^2 - r\,(db/dt)^2 \sin^2 a\right]$$
$$+ \underline{n} \left[2\, dr/dt\, da/dt + r\, d^2a/dt^2 - r\,(db/dt)^2 \sin a \cos a\right]$$
$$+ \underline{p} \left[2\, dr/dt\, db/dt \sin a + r\, da/dt\, db/dt \cos a + (db/dt)^2\, r \sin a\right]$$

Now, let us turn our attention to the forces acting on each of our three masses. Let us define the origin of our coordinate system to be the center of mass of the three bodies. Since we are assuming the system is not being acted upon by outside forces, there is no accelleration of the center of mass. Let us denote the three masses by M_1, M_2, and M_3. In addition, subscripts on r, a, or b will refer to the coordinate of that particular body. Moreover, subscripts will also be used on unit vectors according to the mass to which they refer.

Remember, now, the vectorial nature of the gravitational force. Then the force on M_1, call it $\underline{F}_1$, can be written

(6) $$\underline{F}_1 = G\, M_1 \left[M_2\, \underline{S}_{12}/(S_{12})^3 + M_3\, \underline{S}_{13}/(S_{13})^3 \right]$$

where $\underline{S}_{12}$ and $\underline{S}_{13}$ are the vectors from M_1 to M_2 and M_1 to M_3 respectively, and S_{12} and S_{13} are the magnitudes. But

(7) $$\underline{S}_{12} = r_2\, \underline{m}_2 - r_1\, \underline{m}_1$$

(8) $$\underline{S}_{13} = r_3\, \underline{m}_3 - r_1\, \underline{m}_1$$

while we have

(9) $$(S_{12})^2 = (\underline{S}_{12})\cdot(\underline{S}_{12})$$

(10) $$(S_{13})^2 = (\underline{S}_{13})\cdot(\underline{S}_{13})$$

All of these may be computed by referring to equations (1) to (3), remembering to keep track of supscripts.

But the force may alternately be described by

(11) $$\underline{F}_1 = \underline{m}_1\, (\underline{F}_1\cdot\underline{m}_1) + \underline{n}_1\, (\underline{F}_1\cdot\underline{n}_1) + \underline{p}_1\, (\underline{F}_1\cdot\underline{p}_1)$$

Finally, we are left with, after computing the above by substituting (7) and (8) into (6) and then into (11); and finally equating coeficients between (5) and (11) to leave us:

(12) $$d^2r_1/dt^2 - r_1\, (da_1/dt)^2 - r_1\, (db_1/dt)^2 \sin^2 a_1 = G \left[M_2/(S_{12})^3\, (r_2\, \underline{m}_1\cdot\underline{m}_2 - r_1) + M_3/(S_{13})^3\, (r_3\, \underline{m}_1\cdot\underline{m}_3 - r_1) \right]$$

(13) $$2\, dr_1/dt\, da_1/dt + r_1\, d^2a\, /dt^2 - r_1\, (db_1/dt)^2 \sin a_1 \cos a_1 = G \left[M_2\, r_2\, \underline{m}_2\cdot\underline{n}_1/(S_{12})^3 + M_3\, r_3\, \underline{m}_3\cdot\underline{n}_1/(S_{13})^3 \right]$$

(14) $$2\, dr_1/dt\, db_1/dt \sin a_1 + r_1\, da_1/dt\, db_1/dt \cos a_1 + r_1\, d^2b_1/dt^2 \sin a_1 = G \left[M_2\, r_2\, \underline{m}_2\cdot\underline{p}_1/(S_{12})^3 + M_3\, r_3\, \underline{m}_3\cdot\underline{p}_1/(S_{13})^3 \right]$$

These are the desired equations of motion. Similar equations may be gotten for M_2 and M_3. Of course these equations are, in general, not solvable. Nevertheless from these many useful and important results may fall out, and I will begin to discuss these next month.

Still, let us examine what we have a little more closely. To begin with. let M_3 go to zero and r_3 go to infinity. Then, if $a_1 = a_2 = pi/2$, the above equa tions reduce to a simple and fimiliar form, they become a set of equations describing the two-body problem. Note if we do not let all a-terms drop out, we still have a two-body problem, but the equations are no longer solvable.

.....Ed Woerner

Gravitational Radiation

On Thursday, February 24, Dr. Campbell of the University of Nebraska department of physics presented a colloquium on gravitational radiation.

Dr. Campbell's presentation began with a review of experiments which revealed the existence of gravitational radiation, as predicted by general relativity. However, as he explained, difficulties in interpreting the data arise in that if the radiation is assumed to be isotropic, each pulse contains about 10^{54} ergs of energy, about that of the rest mass of the sun. Since estimates are that about ten pulses occur daily, we are led to a maximum age for a galaxy like ours of 10^8 years, which is far too short.

Next, ignoring these difficulties for a while, Dr. Campbell showed that from the equations of general relativity we may write a set of equations analogous to Maxwell's equations for electromagnetics. From these we can show that only a changing quadrupole (or higher pole) can produce gravitational radiation.

Following this came some discussion on polarization and then a discussion of the mechanics of the experiments planned to detect the variously polarized radiation.

At last, Dr. Campbell returned to the problem of sources. His calculations show that only exotic sources such as the collapse of a star into a black hole, or a binary composed of two black holes will serve.

Ed Woerner

The Age of Aquarius

A popular song claims that the age of Aquarius is dawning. Such a claim, however, is a little hard to justify astronomically.

Some three millenia ago, sky watchers noted that the sun was always in the constellation of Aries on the vernal equinox. This, they thought, was a constant phenomenon.

Nevertheless, as time passed it became clear that each vernal equinox occurred with the sun a little closer to the constellation of Pisces. Finally, by the year 220 A. D. we had actually entered the age of Pisces.

Still, the advance of the equinoxes continue due to the processions of the earth's axes. By this I mean that the earth is spinning like a top, each spin taking 26,000 years. It is this spin which will eventually cause the vernal equinox to enter Aquarius, but not for another 405 years, or the year 2376.

Right now, the sun is in Pisces on March 21. Nevertheless, people born on March 21, are called Arians. Such inaccuracies cause astronomers to loose patience with astrologers.

Ed Woerner

Following is a copy of our membership list as I have it. Please let me know if there are any ommissions or corrections. Thank you........Ed

1.	Donn Baker	2616 N. 59	City	68507
2.	Felis Cavosic	4116 "G" St.	City	68510
3.	Dr. John Clothier	355 S. Cotner	City	68510
4.	Monte Cole	800 Eldon Dr.	City	68510
5.	Dan Cowell	1212 Lake St.	City	68502
6.	Brian Dodson	1522 Kingston	City	68506
7.	Harlan Franey	1734 S. Cotner	City	68506
8.	Dr. James Gardner	3333 Starr	City	68503

9.	Steve Haack	5011 Glade	City	68506
10.	Dick Hartley	320 Wedgewood	City	68510
11.	Jim Hoskins	Route 2, Box 659	Royal, Ark.	71968
12.	John Johnson	4900 Huntington	City	68504
13.	Phil Kelton	4645 Dudley #12	City	68503
14.	Werner Klammer	Route #1	Seward, Neb.	68434
15.	David Kubicek	6927 Lexington	City	68505
16.	Steve Kunkee	1216 Ivinson #1	Laramie, Wyo.	82070
*17.	Dr. Robert Manthey	1130 "O" St.	City	68508
18.	Prof. Carrol Moore	1140 N. 79	City	68505
19.	Earl Moser		Hickman, Neb.	68372
20.	Patrick Nelson	2301 "A" St.	City	
21.	Bill Noel	1646 David Dr.	City	68504
22.	Lawrence Pilgram	1836 S. 58	City	68506
23.	Chris Pratt	2019 Ryons	City	68502
24.	Philo Prell	4425 Randolph	City	68510
25.	James Rogers	8211 S. Cherrywood	City	68510
26.	Steve Roper	5731 Glade	City	68506
27.	Eric Rudd	6541 Rexford	City	68506
28.	Brian Rugg	3468 Woods	City	68510
29.	Roger Severns	3717 S. 18	City	68502
30.	Larry Stepp	910 Eldon Dr.	City	68510
31.	Lee Thomas	1025 N. 63 #107	City	68505
32..	Jess Williams	7844 S. Sycamore	City	68520
33.	Ed Woerner	4530 Adams	City	68504

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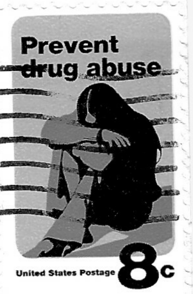

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