TO ALL MEMBERS AND FRIENDS: A VERY HAPPY NEW YEAR AND GOOD SEEING DURING THE YEAR ✳✳✳

JANUARY MEETING: For our first meeting of the New Year (January 11, 1974, 8:00 p.m., Club Room, Buffalo Museum of Science) we are happy to welcome Mr. DALE HANKIN, Editor of Modern Astronomy, who will present an illustrated lecture on ASTROPHOTOGRAPHY. Recently Dale and his wife Linda have started an atlas of the Milkey Way using small cameras (see Modern Astronomy Nov/Dec 1973, p. 130). If you want to learn more about astrophotography without elaborate equipment, you must hear this talk. WELCOME DALE HANKIN!

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FEBRUARY MEETING: The second meeting of the New Year will take place on Friday, February 8, 1974, at 8:00 p.m. in the Museum's Club Room. It will feature a lecture by Dr. JOHN E. MACK entitled "The Quest for the Black Hole." Dr. Mack has recently joined the faculty of the State University College at Buffalo as Assistant Professor in the Dept. of Geosciences. Dr. Mack received his PhD from the Catholic University in Washington, D.C. Prior to coming here, Dr. Mack was associated with the Space Science Laboratory of the University of California at Berkeley and with NASA at Houston. His specialty is High Energy Astrophysics, particularly X-Ray Astronomy. In his lecture Dr. Mack will present a survey on the properties of Black Holes and will concentrate on Cygnus X-1. Evidence points to this X-Ray source as being a Black Hole. Don't miss what promises to be an exciting lecture. We are very happy to welcome DR. MACK!
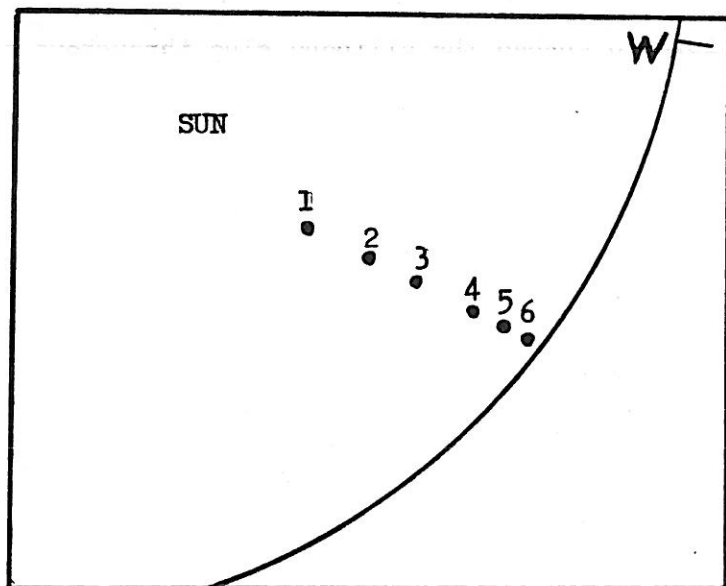
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* THE TRANSIT OF MERCURY OF NOVEMBER 10th, 1973. * By Dr. Fred W. Price

The morning of November 10th looked promising for viewing the transit of Mercury. I arose before sunrise at 6 a.m. and looking out of my bedroom window toward the northwest I saw clear skies and a splendid near-full Moon low in the sky surmounted by a fine "column" (an atmospheric phenomemnon). The only possible hazard to perfect transit observation seemed to be some banks of stratus cloud low in the east. The morning was beautiful, crisp and cold. After a hurried breakfast I arrived at the Science Museum in a taxicab just before 7 a.m. where I met Ernst Both who was busy with preparations for observing the transit. He, Dr. Fred West and son, Carl Milazzo and another BAA member (unidentified) plus myself were the only Club members who had come to view the event.

From the roof of the Museum we watched the Sun rise behind low cloud banks and it was interesting to see another atmospheric phenomenon in the form of a "double Sun" with a double "column" above it. We returned downstairs to the Gee Solar Observatory to watch the large projected image of the Sun in the observing room where the dim oval image on the screen, crossed by horizontal parallel bands of cloud, bore a striking resemblance to a telescopic view of the planet Jupiter. The Sun slowly brightened and at about 7:20 a.m. Dr. West excitedly pointed out a small black dot near to the limb. I used my Polaroid Land Camera (model Automatic 100) to take a whole disc photograph of the projected image of the Sun; the black dot we could see might have been a sunspot but shortly afterwards, the Sun rose clear of the clouds and was seen to be completely

free of spots except for the small quivering black blob, about one centimeter in diameter, that was Mercury. The Sun's limb was trembling and there were strong chromatic effects due to atmospheric dispersion but that tiny black, color-fringed dot held everybody enthralled. I took a series of close-up pictures at intervals of about ten minutes with the aid of the close-up lens and a prism attachement over the viewfinder that eliminates parallax effects. Once or twice in between times I dashed upstairs to the Kellogg Observatory to view the transit through the 8-inch refractor fitted with a polarizing helioscope, and the 6-inch refractor attached to it, with a reflecting Optron objective filter.

I was in the observing room again as the moment of third contact approached. I took my last picture as Mercury was nearing the Sun's limb and was well satisfied with the series of shots I had taken. Ernst Both and I watched the egress of Mercury from the Sun's disc while the others were upstairs. It was almost with regret that we saw the last trace of that trembling dot pass from the solar disc (at about 8:20 a.m.), realising as we did that this would be the last time that a transit of Mercury would be visible from Buffalo until well after the turn of the century. The accompanying sketch is a free-hand composite based on my photographs. My photographic record of the recent pair of transits of Mercury is now complete. The photographs of the 1970 transit were good but observation of third and fourth contact on that occasion was spoiled by clouds at the last moment. Myself and the other BAA members present are grateful indeed to Ernst Both for placing the Museum's fine observing facilities at our disposal for viewing the transit, which with the fine weather (which shortly after the transit clouded over) made for an unforgettable experience. It is a pity that so few members of the BAA availed themselves of this and similar opportunities in the past.

Successive positions of Mercury at the following approximate times (EST):

1: 07:35 a.m.; 2: 07:47 a.m.;

3: 07:55 a.m.; 4: 08:05 a.m.;

5: 08:11 a.m.; 6: 08:15 a.m.

The "W" marks the approximate position of the west point on the Sun's limb.

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* NOVEMBER BAA INSTRUMENT SECTION MEETING * Reported by Warren Steinberg

The greater part of the meeting was given up to Mr. Gordon Rees, who talked on his technique of making molds for pitch laps. From all accounts ATM's have considered lap making a tedious and messy job. They thus have devised various methods to ease their pains, among them: saws and soapsuds, candles and razor blades, knives, rulers, soldering irons, honeycomb foundations, and so on. Recently the rubber mold method has been considered to be most efficient. But one problem still exists with these rubber molds, in that most of them are commercially made and usually of one set design. Hence this

provides no great variety in polishing and figuring methods and the ATM still has to alter the pitch lap to suit his purpose. It is out of this frustration that people like Mr. Rees have devised a method to enable ATMs a chance to easily make a number of molds, each mold with a different purpose. Materials needed to make a button pattern and mold: 1) A length of dowling - the diameter gauges the diameter of the individual facets; 2) Circular piece of wood - the diameter equals the size of the mold required. Thickness for practical purposes should not be less than ¼ inch; 3) A piece of paraffin; 4) A tube of silicone seal glue (sold in various colors; when dry it is very rubbery and does not stick to the pitch) - this will eventually become the mold; 5) Elmer's glue; 6) A flat piece of glass (at least one foot square); 7) Medium grade sandpaper; 8) Newspapers; 9) A length of aluminum stripping or a large hose clamp (to act as a silicone glue dam while making the rubber mold; dimensions depend on the size of the pattern).

Method: 1. Cut off equal thicknesses of doweling - the quantity depends on the size of the lap desired. The thickness of the pieces equals the thickness of the resulting lap and should be ¼ inch or less (except for larger mirrors); 2. Now glue the short pieces of doweling to the large circular piece of wood. Make sure of these two things: a) make sure the pattern is off-center to discourage any zones during polishing; better yet, glue the pieces in an asymmetrical design; b) make sure the pieces are equally separated from each other. Some master optical workers might want to alter the distances between facets to suit their own figuring purposes. When the glue has dried: 3. Set out on a table the square piece of glass and place on top of it, face up, the piece of sandpaper. Set the wood pattern face down on the sandpaper and start moving the pattern back and forth; every now and then rotate the pattern to prevent zones on the pattern and on the resulting mold; after this, heat up the paraffin and dip or paint it in the pattern to act as a sealer. 4. When the paraffin has hardened, place a metal dam or hose clamp around the wooden pattern, making sure the top of the dam stays even with the top of the facets. It is now possible to spread the silicone glue throughout the pattern making sure that all areas are filled. To prevent a veil (useless material on the edges of the mold) and to keep the thickness of the mold even, one should spread the excess glue out, by immediately placing the whole pattern face down on the newspapers and pushing it about.

The mold will be ready when the glue has dried (ca. 24-36 hours). Mr. Rees suggests that to make the pitch lap one should use a technique found in Allyn Thomson's book: "How to make a telescope," where the pitch is first poured onto the surface of the mirror upon which the mold has been placed. Happy mirror making! **** PLEASE NOTE: The January meeting of the Instrument Section (January 25, 1974) will be held at the house of Tom Dessert (25 Francine Lane, Cheektowaga, N.Y.). For directions on how to get there, please see Tom at the meeting on January 11, or call him at 674-3922. ****!!!!****!!!!****
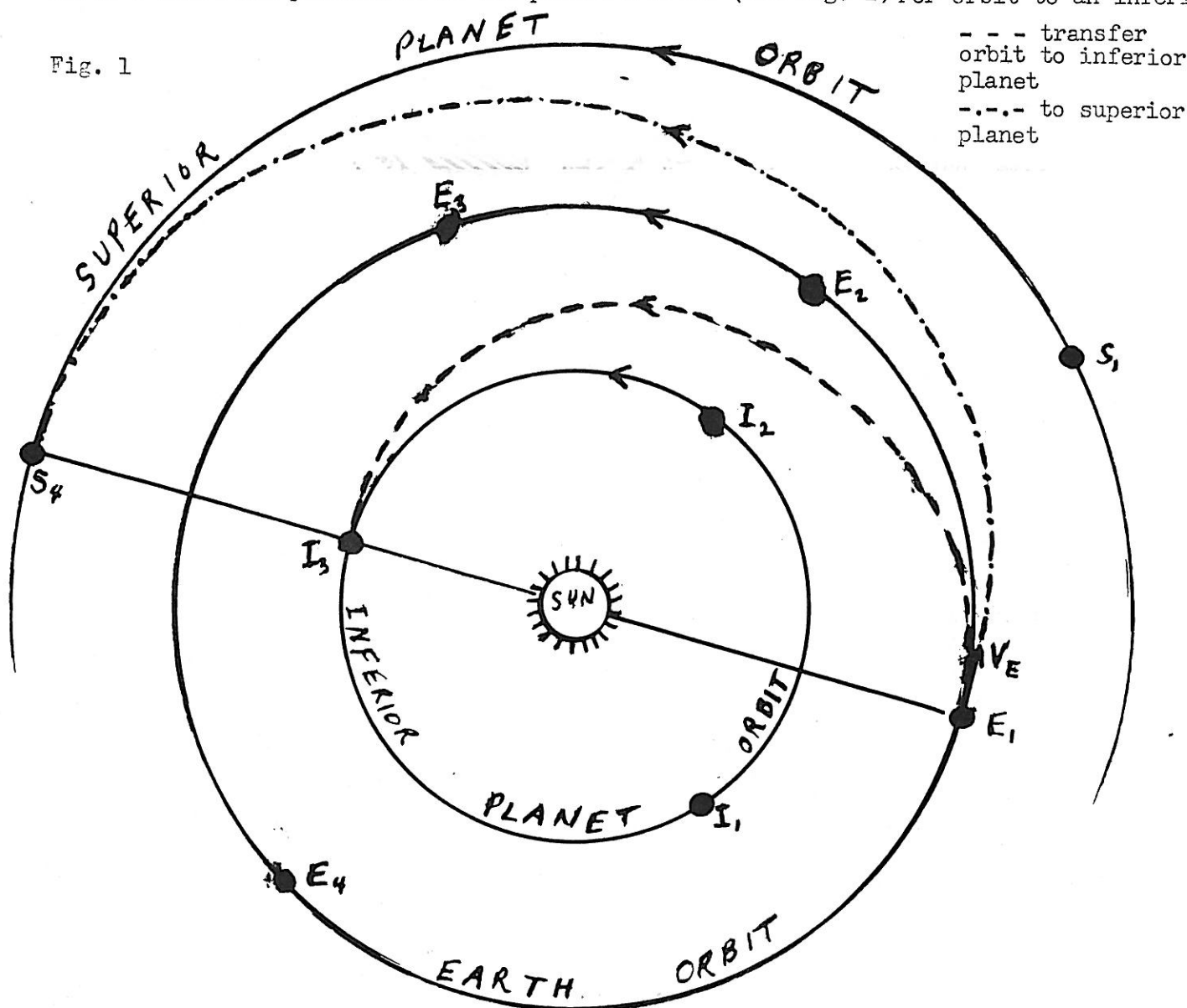
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** SPACECRAFT LAUNCH WINDOWS ** By Dr. Frederick R. West

Why is it that every so often there are spacecraft launches toward a given planet, which sometimes follow each other within a few days or weeks, while for a long time afterwards no spacecraft is launched toward the planet? The answer lies in the existence of "launch windows" from the Earth to other planets, a time interval of a few weeks when conditions are favorable for launch of spacecraft from the Earth toward a given planet. There are two reasons for such launch windows: I) The nature of the transfer orbits from the Earth to another planet. With present chemical rockets, the rocket stages burn during spacecraft launch for a total time of less than an hour while the spacecraft is very close to the Earth; in fact, final stage burnout occurs almost always while the spacecraft is still in the Earth's upper atmosphere. After burnout the spacecraft moves, pulled by the gravitational forces of the Earth and the Sun toward the planet of interest. Once the spacecraft leaves the vicinity of the Earth-Moon system (distances of more than 1,000,000 km from Earth), it moves in an elliptical orbit around the Sun, the transfer
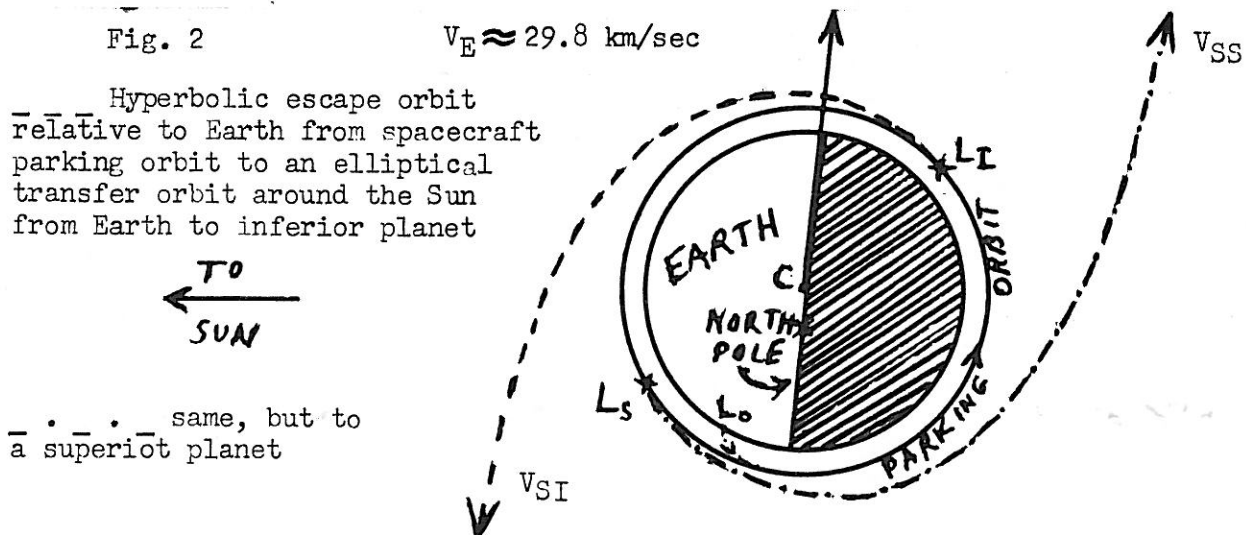
orbit, until it approaches the planet; although small rockets on the craft can change the transfer orbit (so-called "midcourse corrections"), these orbit changes are nearly always small. To maximize the spacecraft payload to the planet, the transfer orbit must have its minimum and maximum distances from the Sun (=perihelion and aphelion, respectively) at the orbits of the Earth and the other planet. Deviation from this ideal orbit (the so-called Hohmann transfer orbit) requires a higher burnout velocity of the final rocket stage, and less spacecraft payload. Since as of this writing, the most massive payload sent to the vicinity of another planet is 5 short tons (= Mars 3), maximization of spacecraft payload is of utmost importance. II) After spacecraft launch on a transfer orbit as close as possible to the ideal Hohmann transfer orbit, it is necessary that the planet of interest be at or close to an intersection of its orbit and the craft's transfer orbit for a successful spacecraft encounter with palnet to occur.

The times when the Earth and another planet are in the right aspect to satisfy both of the above conditions is the "launch window" to the planet; it occurs only once each synodic period for each planet. The "launch window" usually lasts two to five weeks, during which time the actual spacecraft transfer orbits achieved do not deviate much from the ideal transfer orbit. Spacecraft launches outside the "launch window" require excessive amounts of rocket fuel which reduces markedly possible payloads. For a spacecraft to an inferior planet, the ideal transfer orbit has its aphelion at the Earth's orbit and perihelion at the planet's orbit (see Fig. 1) For orbit to an inferior

Fig. 1

- - - transfer orbit to inferior planet
-.-.- to superior planet

planet, the launch window occurs with the Earth and inferior planet at positions E_1 and I_1 respectively (in Fig. 1) in their orbits (near greatest eastern elongation). Inferior conjunction (I_2 and E_2) occurs with spacecraft enroute, and arrival at the planet at I_3 and E_3. The launch window to superior planet S occurs with the Earth and planet at E_1 and S_1 respectively, with spacecraft arrival at the planet at S_4 with Earth at E_4 (sometime after opposition, between E_2 and E_3). The launch window to Venus occurs near the aspect of greatest eastern elongation. Spacecraft launch from Earth is best carried out in two steps: 1) The craft together with the last rocket stage is launched into a low (ca. 100 miles above the surface) Earth orbit, the so-called "parking orbit." Then 2) after one or more revolutions in parking orbit, the last stage ignites to launch the craft into a hyperbolic orbit relative to the Earth along which it will escape into interplanetary space (see Fig. 2) into the transfer orbit. The transfer orbit is determined by how the spacecraft's escape velocity vector from the Earth adds to the Earth's orbital vector around the Sun. For launch to an inferior planet, the

Fig. 2 $V_E \approx 29.8$ km/sec V_{SS}

Hyperbolic escape orbit
relative to Earth from spacecraft
parking orbit to an elliptical
transfer orbit around the Sun
from Earth to inferior planet

‾‾‾‾ TO
← SUN

‾ ‧ ‾ ‧ ‾ same, but to
a superior planet

V_{SI}

last stage rocket must ignite near point L_I in the parking orbit so that far from the Earth the spacecraft escape velocity V_{SI} is oppositely directed (or subtracts from) the Earth's escape velocity V_E. Then the spacecraft's aphelion velocity around the Sun is less than that of the Earth and the Sun's gravity pulls the spacecraft closer to the Sun along its transfer orbit. In Fig. 2 we see that after liftoff from the Earth's surface at L_o, an easterly launch places the craft plus the last rocket stage into a low parking orbit around the Earth. Successful last stage ignition at L_I will send the craft into escape hyperbolic orbit with velocity V_{SI} relative to Earth at infinity. Last stage ignition at L_s produces spacecraft velocity V_{SS} relative to Earth at infinity.

For a spacecraft to a superior planet, the ideal transfer orbit has its perihelion at the Earth's orbit and aphelion at the planet's orbit (Fig. 1). Launch windows for Mars and Jupiter occur about 3 months before the aspect of opposition for those planets. Ignition of the last stage rocket must be near L_S in the parking orbit, nearly opposite point L_I (Fig. 2). Then when the spacecraft gets far from the Earth along its hyperbolic escape orbit, its escape velocity V_{SS} from the Earth is parallel to (or added to) the Earth's orbit velocity around the Sun. Then the craft's perihelion velocity around the Sun is faster than the Earth's orbital velocity, which causes the spacecraft to move out beyond the Earth's orbit in its transfer orbit. (To be concluded in March-April issue).

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METEOR SHOWERS FOR JANUARY AND FEBRUARY. By Darwin Christy

On January third, one of the strongest annual displays of meteor showers are the

Quadrantids. Because of the Spectrum publication schedule, this shower has already past, but I expect to count a large number of micro-meteorites. As many as 110 meteors/hour have been counted in past years, although only 35/hour are about the average number. The Quadrantids have a very short maximum, from about five to six hours, and hence are not visible over the entire world. The radiant lies halfway between Corona Borealis and Ursa Minor. Average brightness is about 3^m with one or two fireballs.

The Aurigids, with the radiant in Auriga, occur in February. On the evening of the 8th and morning of the 9th about 12 meteors/hour may be observed. It is not a spectacular display by count but it does produce some very bright meteors (m=1) and larger than usual micro-meteorite counts may be expected.

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* SPY AND TELL * What happened to our Pres., Darwin Christy? He jokingly announced at the last meeting that he is thankful to be alive - well, he spent Thanksgiving Day in the hospital and looking ahead to Christmas, realized his most cherished Christmas present to be his LIFE. Seems he tried to sky-watch from a power company bucket truck - to be different, from the outside (!) of the bucket. But the control to raise the truck jammed and he went higher than intended - his partner tried in vein to get the ladder to him and his grip failed, falling 13 ft, hitting his head first and then the back and right side. Believing him dead at first, his partner heard a grunt and moan and summoned help. Warren Steinberg arrived and saw all the commotion - asked what had happened, was told "some fellow fell and got hurt", proceeded on his way! (Not realizing there lay his Pres.). Darwin's hurts were seven broken ribs, torn cartilages and ligaments on the left side, a slight contusion, and lacerated left leg (only 3 stitches!), resulting in eleven days at Sister's Hospital. We are happy to know Darwin is back and almost completely healed.*** *** FRED PRICE seen on WKBW's "Dialling for Dollars" on November 26th in a six-minute interview on Comet Kohoutek. He showed Orrin Christy's recent Kohoutek photo while discussing comets in general and Kohoutek in particular. ***XXX*** IMPORTANT: Edith Geiger mentions that the Philharmonic tickets (for the Gershwin Concert, March 8, 1974) will be available at the January meeting. Please be prepared to pay for the ones you ordered at the meeting, or if impossible, at the February meeting at the latest!!!!! ***XXX*** The Buffalo Museum of Science is sposoring a Kohoutek Photo Contest - two categories: 1. Black and White, 2. Color. In both cases, 8 X 10, unmounted, original prints only. Three cash prizes in each category. The prints become the property of the Museum and are non-returnable. Entries should be sent to: Ernst E. Both, Curator of Astronomy, Buffalo Museum of Science, Buffalo, N.Y. 14211 by March 1. The best 150 photos will be displayed in a special exhibit at the museum. All residents of the Niagara Frontier are eligible. Details at the January meeting or call 896-5200.

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Buffalo Astronomical Association, Inc.
c/o Buffalo Museum of Science
Humboldt Park
Buffalo, N.Y. 14211

John Riggs
255 Grimsby Rd.
Kenmore, N.Y.
14223

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