STAR DUST

JANUARY 1, 1971 *** VOLUME XXVII *** NUMBER 5 ***

Radioastronomy of Interstellar Gas

Radio Astronomy had its beginning in 1932 when Karl Jansky found that the noise in early radio telephone circuts was periodic with the rotation of the earth. Since that time large radio telescopes and very sensitive receivers have been built which allow radio astronomers to study many parts of our Galaxy which are inaccessible to optical astronomers.

Recently molecular lines have become very important in studying the clouds of gas and dust which inhabit the regions between the stars. These clouds are the material out of which stars and planets condense. In the past three years a number of complex molecules have been discovered in these clouds by means of their radio spectrum. Molecules identified include: amonia, water, formaldehyde, carbon monoxide, cyanogen, hydorgen cyanide, cyanoacetylene, methyl alcohol, formic acid and the hydroxyl radicle.

The radio lines from these molecules provide astronomers with a very important means of determining the velocity, turbulence, temperature and density of interstellar clouds. Some of the molecules also exhibit characteristics of maser emission and refrigerator absorbtion which are apparently related to the peculiar physical conditions of the cloud. The temperatures and densities are extremely low while the velocities and distances are very large. The chemical evolution in these is very advanced and complex organic molecules are present in relatively large abundance. The study of interstellar clouds suggests that the evolution of living things on earth may have had its beginning inside a similar cloud five billion years ago.

Doctor David Buhl graduated from MIT in 1960 with a Masters in electrical engineering. He then went to the Lawrence Radiation Laboratory in Livermore, California for three years where he worked on a variety of engineering projects including an infra-red television transmission system. The next three years were spent at the University of California at Berkeley on the topic of radiation anomalies in lunar craters, where he obtained his Ph. D. In 1967, Dr. Buhl joined the scientific staff of the National Radio Astronomy Observatory where he found himself in

charge of the solar system. In addition to radio observations of the Moon and Sun, he has been involved in an interferometer project to determine surface temperatures on the planet Venus and some studies of the radio emission from the radiation belts of Jupiter. Over the past three years Dr. Buhl and Dr. Lewis E. Snyder have been actively pursuing molecular lines in the interstellar medium. Coming in second on the detection of water vapor clouds in the Galaxy, they went on to discover formaldehyde, hydrogen cyanide and X-ogen (a quote, not a misprint, ed.). Since these molecules are important to the chemical evolution of life, Dr. Buhl and Snyder are continuing to look for other links in the evolutionary chain.

The Light of Mercury and Other Elemental Facts

In recent weeks my mail has brought glimmers of hope in the problem of excessive outdoor lighting. One is the recognition of the problem by a conservation organization and the other is favorable action by a zoning board.

Included in the Fall 1970 Progress Report of the World Wildlife Fund (910 17th St. N.W., Wash. D.C.) is a pamphlet written by Malcomb B. Wells of Cherry Hill, New Jersey. This lists a dozen areas in which man has made a mess of things and what he can do about each of them. I quote the last item on the list.

"Destruction of Night -- Night totally destroyed; a whole generation made unfamilliar with the wonder of darkness, of the moon, and of bright stars. Possibly one of the biggest treats of all, but it's too soon to tell yet. Unless a lot of us care there is not much we can do. Kiss the stars goodbye, I guess and get ready to tell our grandchildren why we wrecked so many wonders. How the wild animals and plants are affected by this lighting madness no one knows - and few care. Strict laws, overdue even now will limit artificial lighting to the surfaces that need light and prevent all light spillage into the sky and into others eyes."

The second item is Bob Wright's letter to the November issue of Reflector which quotes the lighting ordinance passed by a zoning board in the area of the new observatory site of the Lehigh Valley Astronomical Society.

It is encouraging to see that someone besides astronomers care and are becoming concerned and that lighting ordinances can be enacted.

If further progress is to be made there must be more publicity and it must come from we who are most directly concerned. Cooperation through the astronomical societies is needed but we as individuals should not wait for a committee to act. We can each get a word in whenever the opportunity arises when speaking to groups or individuals or by writing letters or school essays. How about some of the Juniors using "Dark Pollution" as the subject of a Science Fair Project?

Lyle T. Johnson.

President's Notes

Now is the time for NCA Junior members to plan astronomical projects for exhibit in the Spring Science Fairs. In past years, NCA members' projects have won many awards, frequently going to a hard core of serious amateurs. I'd like to see more and better competition. To be really sucessful, a projects based on some astronomical theory requires many months of study and planning for successful execution. A project based on astronomical observation requires the choice of a narrow enough area, optimum use of the instrumentation available and good luck with the weather. NCA awards free one-year memberships to the best exhibitors in the county-wide fairs. Good Luck!!

One interesting result from the Orbiting Astronomical Observatory II is that OH (hydroxyl) radical exceeded cyanogen and molecular carbon in quantity by several hundred times in comets Bennet and Tago-Sato-Kosaka. This means that Water-Ice as well as methane ice was present.

The Saturday Star for December 13th had an excellent short feature article on Dr. Werner VonBraun of NASA, in its magaz ine section.

The officers and trustees of NCA wish all members a happy and a pros perous New Year.

There will be no solar eclipse this year but we can look forward to a total lunar eclipse on February 10th and a very close approach of Mars in August. I hope to interest NCA observers in a program of simultaneous observation of the planets beginning with Saturn in February continuing with Jupiter during the spring and culminati ng with extensive drawing of Mars this summer. Plans for this program of Friday and or Sunday evening observing will be formulated at the January 23rd discussion group and announced at the February meeting.

A thorough check of the possibility of having the NCA mailing list serviced by the National Bureau of Standards conducted by Jerry Hudson and myself revealed that this privilege is open only to those societies some of whose membership are participating as part of their official NBS duties.

An interesting finding from Apollo 12: In the 31 months between the landing of Surveyor 3 and the landing of Apollo 12, no new meteor craters larger than 1.5 mm in diameter were detected.

Bill Winkler

The December Speaker

Dr. Elihu Boldt of the Goddard Spaceflight Center discussed current work in X-Ray Astronomy at the December 5th meeting of NCA. About 40 objects are now known to emit this high energy radiation having wavelenghths less than 40 Å. Two of the most powerful sources are the crab nebula and a nebula in scorpius. Both balloons and rockets are used to carry instruments for this work above the limiting atmosphere. Forthcoming satellites with their major purpose the extending of the regions explored for X-ray sources will be the first devoted completely to this branch of astronomy and should greatly expand its knowlege. Such a satellite was launced by the Italians on December the 11th.

Bill Winkler

Calendar

January 9th - 6:15 PM, Dinner with the speaker at Bassin's, 14th and Pennsylvainia Ave., N.W. Reservations by noon Saturday. Call Winkler 762-5135 or Legowik 946-8996.

January 9th - 8:15 PM, January meeting of NCA. Dr. David Buhl of NRAO speaks on Interstellar Molecules. Department of Commerce Auditorium, 14th and E street, N.W.

January 23rd - 8:15 PM. Discussion Group, Department of Commerce Room 2062, 14th and E, N.W. Problems of planetary drawing and plans for some NCA simultaneous planetary observation periods SPOP, will be discussed.

January 8, 15, 22, 29th. Telescope making classes, basement of the McKinley Bldg. American University Physics Building, conducted by Jerry Schnall. For more information call EM 2-8872.

January 16th, 2:00 PM, Juniors Meeting of the MD. D.C. Juniors at the Chevy Chase Library on Connecticut Avenue. For more information call Jean Radoane at 434-0443. Jerry Hudson will conduct a telescope clinic.

January 23rd, 7:30 PM. Observing at the 5-inch at the Naval Observatory with Larry White. For additional information call 461-9681.

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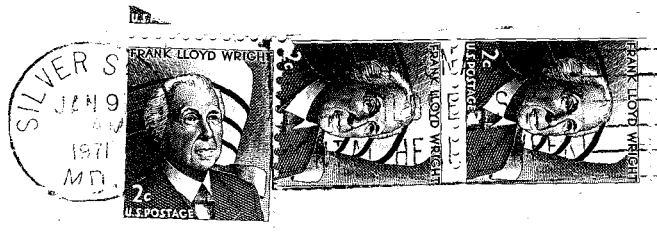

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1971 TOTAL OCCULTATION PREDICTIONS FOR WASHINGTON,DCC. -- WEST LONG. 77.067, LAT. 38.920, ELEV. 86M -- STATION CODE SA104

DAY D	TIME-UT H	M	S	P	AC D	USNO REF NO	MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. ° / //	SP	PCT SNLT	WA	LONG LAT LIB	LAT LIB	SAO REF NO	A M/O	B M/O	C S/K	MN AZ	VA	HA
JANUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** JANUARY	** **	**	**	**	**	**	**	**	**	**	** JANUARY		
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2	01	54	32	D	9	Z24402	9.0	12		85	14N	61	351-06	6086	225154.918	-53003.46	G0	26+	12.3	0.4	-1.6	146370	0.5	4.0	1.4	253	303	70
2	01	44	26	D	4	Z24412	8.9	14		35	75N	61	52-06	6090	225238.342	-53911.14	K0	26+	73.4	0.4	-1.6	146378	-0.4	0.0	1.0	251	5	67
2	22	39	19	D	5	Z25044	9.1	50	-8	35	57N	73	33-00	4546	233856.297	1359.65	K2	36+	55.4	2.0	-2.9	128315	-1.1	1.5	0.8	196	21	10
2	22	47	13	DA	5	3489	7.7	50	-9	27	62N	73	38-00	4547	233911.449	1521.59	K0	36+	66.5	2.0	-2.9	128319	-1.2	1.3	0.8	199	24	12
3	01	04	35	D	7	Z25075	9.0	34		75	24N	74	0+00	5038	234145.514	5709.17	K0	37+	22.5	1.6	-3.1	128343	-0.8	2.9	1.3	239	318	46
3	00	35	22	D	5	Z25076	8.8	38		26	67N	74	43+00	5039	234145.786	4438.22	G5	36+	65.4	1.7	-3.1	128344	-1.0	0.7	1.0	232	5	38
3	01	12	10	D	14	Z25092	8.0	32		97	29S	74	127-00	4561	234249.309	3307.88	F8	37+	149.0	1.6	-3.1	128354	-3.0	-6.0	0.3	240	84	47
3	22	58	19	D	17	Z00405	9.1	58	-11	35	78S	87	79+06	0063	3046.221	64555.90	A0	47+	101.3	3.1	-4.3	109261	-2.2	0.4	0.2	185	75	3
3	23	04	40	DA	16	0068	5.7	58		39	78S	87	78+06	0064	3054.384	64749.27	A0	47+	100.6	3.1	-4.3	109262	-2.1	0.4	0.2	188	72	4
3	23	05	53	D	17	Z00407	9.2	58		34	77S	87	79+06	0065	3056.199	64752.45		47+	101.6	3.1	-4.3	109263	-2.2	0.3	0.2	189	73	5
4	00	45	38	D	71	Z00416	8.7	49		95	-1N	87	335+06	0067	3138.883	72538.16	G0	48+	357.6	2.8	-4.4	109270	**********			228	300	29
GRAZING OCCULTATION OF Z00416 NEARBY -- APPROXIMATE NORTHERN LIMIT -- LAT. = 39.27 - 0.42(WEST LONG. - 77.07).																												
4	01	07	24	D	19	Z00427	8.8	46		95	4N	87	340+06	0068	3215.240	73141.16	G0	48+	2.6	2.7	-4.5	109277	1.5	8.2	1.7	234	301	35
4	01	23	42	D	5	Z00448	8.4	43		25	57N	88	34+06	0072	3338.145	73356.29	F8	48+	56.5	2.7	-4.5	109294	-1.0	1.2	1.0	238	352	38
4	01	38	20	D	5	Z00464	8.5	41		25	77S	88	80+06	0075	3427.795	72704.86	A2	48+	101.9	2.7	-4.5	109305	-1.5	-0.7	0.8	241	36	42
4	02	51	16	D	4	Z00482	8.6	28		15	76N	88	53+07	0080	3612.827	75149.54	K5	49+	75.0	2.5	-4.6	109318	-0.8	0.1	1.0	256	3	60
4	03	33	19	D	5	Z00504	8.6	21		55	44N	89	21+07	0084	3658.959	80708.48	K0	49+	43.4	2.5	-4.6	109337	-0.5	1.4	1.2	264	329	70
4	03	28	25	D	6	0085	8.6	21		65	47S	89	110+07	0086	3727.967	74527.74	K0	49+	132.0	2.5	-4.6	109344	-0.7	-2.5	0.8	263	58	69
4	03	42	39	D	4	Z00519	8.7	19		15	81N	89	57+07	0087	3747.737	80259.78	K0	49+	79.7	2.5	-4.6	109350	-0.5	-0.1	1.0	265	6	72
4	03	49	25	D	4	Z00524	8.7	18		15	82N	89	59+07	0089	3801.544	80409.38	F5	49+	81.5	2.5	-4.7	109353	-0.5	-0.2	1.0	266	7	74
4	03	50	45	D	4	Z00525	8.2	17		26	73S	89	84+07	0090	3812.896	75756.02	F5	49+	106.1	2.5	-4.7	109354	-0.5	-1.1	0.9	266	32	74
4	04	24	45	D	6	Z00528	8.9	11		65	36N	89	12+07	0092	3828.529	81955.45	K5	49+	34.8	2.5	-4.7	109357	-0.4	1.9	1.3	272	320	83
4	22	20	25	D	5	Z01195	8.9	59	-4	24	56N	100	35+12	0169	12104.206	125712.05	K2	58+	56.1	4.2	-5.2	092402	-1.0	2.2	0.3	143	64	-18
5	00	09	24	D	5	Z01251	9.0	63		24	82S	100	77+12	0174	12359.524	131433.18		59+	98.0	3.9	-5.4	092430	-2.1	0.3	0.3	198	62	8
5	01	46	51	D	14	Z01268	8.6	52		84	11N	101	350+13	0212	12500.357	134841.63	K2	59+	11.0	3.6	-5.5	092443	0.1	6.5	1.4	238	307	32
5	01	46	10	D	5	Z01284	8.8	52		14	81N	101	60+13	0215	12609.019	134039.15		60+	81.6	3.6	-5.5	092449	-1.5	0.4	0.8	237	18	32
5	02	25	45	D	5	Z01295	8.7	46		34	70S	101	89+13	0219	12717.832	134123.33		60+	110.0	3.5	-5.6	092455	-1.6	-1.1	0.8	247	41	42
5	03	18	28	D	5	0218	8.9	36		24	62N	102	42+13	0222	12821.397	140347.77	K0	60+	62.7	3.4	-5.6	092464	-1.0	0.7	1.0	258	350	55
5	04	54	58	D	4	Z01365	8.8	18		14	77N	102	56+13	0230	13130.634	141916.30	K0	61+	77.1	3.3	-5.6	092505	-0.5	-0.1	1.0	274	3	78
5	05	44	59	D	5	0231	7.9	9		65	50S	103	109+13	0238	13322.615	141423.46	G5	61+	130.1	3.3	-5.6	092523	0.1	-2.0	0.7	261	57	90
5	06	09	29	D	4	0233	6.2	5		47	85N	103	64+13	0240	13414.026	143059.32	B9	61+	85.4	3.3	-5.6	092530	-0.6	-0.4	0.9	285	13	96
5	23	17	56	D	7	0336	7.4	65		65	60S	113	103+17	0339	21609.951	181928.39	F0	70+	122.0	4.8	-6.0	092873	-2.7	-0.1	-0.6	140	135	-17
6	01	28	55	D	8	Z02002	9.0	66		63	54S	114	108+18	0292	21916.305	184445.58	G5	70+	127.4	4.4	-6.2	092894	-2.6	-1.7	0.2	218	78	15
6	02	42	48	D	7	Z02024	8.8	55		63	49S	114	114+18	0297	22105.193	185611.03	F8	70+	133.0	4.2	-6.2	092907	-2.0	-2.6	0.5	245	66	33
6	03	59	55	D	41	Z02036	8.6	41		94	4N	114	347+18	0298	22156.065	193014.94	G5	71+	5.9	4.0	-6.3	092917	**********			262	292	53
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6	05	39	34	DA	16	Z02080	9.2	22		93	16N	115	0+19	0357	22521.365	194415.12		71+	18.5	3.9	-6.2	092954	-2.0	6.2	2.3	278	305	77
6	06	37	03	D	4	Z02117	8.8	12		63	61N	116	45+19	0362	22813.773	194656.48		72+	63.3	3.9	-6.2	092974	-0.4	0.2	1.1	286	352	90

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DAY D	TIME-UT H	M	S	P	AC D	USNO REF NO	MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. ° / //	SP	PCT SNLT	WA	LONG LAT LIB	LAT LIB	SAO REF NO	A M/O	B M/O	C S/K	MN AZ	VA	HA
JANUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** JANUARY	** **	**	**	**	**	**	**	**	**	**	** JANUARY		
6	06	51	43	D	4	0370	6.1	9		57	83N	116	67+19	0365	22901.746	194350.61	F0	72+	85.0	3.9	-6.2	092979	-0.1	-0.5	0.9	288	15	94
6	22	15	27	D	26	Z02611	8.5	49	-3	93	25S	125	143+21	0418	30934.196	221841.97	G5	79+	158.6	5.6	-6.2	075775	-6.6	-5.8	-4.4	100	199	-45
GRAZING OCCULTATION OF Z02611 NEARBY -- APPROXIMATE SOUTHERN LIMIT -- LAT. = 38.52 - 0.75(WEST LONG. - 77.07).																												
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6	22	57	32	D	11	Z02620	8.9	57	-11	83	10N	125	358+22	0450	31001.682	225552.61	K0	79+	14.0	5.5	-6.3	075782	1.0	4.9	1.0	109	52	-34
6	22	54	24	D	8	Z02622	9.3	56	-10	72	19N	125	7+22	0451	31006.998	225508.68	K7	79+	22.7	5.5	-6.3	075784	0.4	4.0	0.6	108	61	-35
6	22	47	21	D	5	Z02631	8.6	55	-9	33	69N	125	57+22	0453	31044.966	224632.43	G0	79+	73.1	5.5	-6.2	075790	-1.0	1.9	-0.3	106	112	-37
6	23	02	06	D	6	Z02640	8.9	57	-12	53	74S	125	93+22	0455	31120.231	223957.57	K0	79+	109.1	5.5	-6.3	075796	-1.8	0.8	-0.7	110	146	-34
6	23	50	05	DA	5	0470	7.0	65		45	82S	126	86+22	0457	31237.090	225100.73	K0	79+	102.1	5.4	-6.3	075806	-2.0	0.8	-0.4	125	131	-22
7	00	45	20	D	5	Z02673	9.0	73		32	75N	126	64+22	0461	31355.001	230639.72	F8	79+	79.2	5.2	-6.4	075816	-1.8	1.3	0.0	154	86	-8
7	01	38	26	D	8	Z02689	7.9	74		64	55S	126	113+22	0465	31516.809	230129.94	K0	80+	128.7	5.0	-6.5	075832	-2.7	-1.7	-0.1	195	100	5
7	02	18	10	D	11	Z02692	9.0	70		82	22N	126	11+23	0430	31526.372	232854.73	F8	80+	26.0	4.9	-6.5	075838	-1.1	4.8	0.9	223	335	15
7	03	33	20	D	6	Z02724	8.9	58		42	73S	127	96+22	0472	31821.962	232025.88	B9	80+	111.4	4.7	-6.5	075868	-1.8	-1.2	0.6	250	43	33
7	03	55	40	DA	6	0483	7.5	54		54	57N	127	46+23	0442	31840.510	233521.40	A5	80+	61.6	4.6	-6.5	075873	-1.7	1.0	0.9	256	351	38
7	03	57	21	D	5	Z02740	8.9	54		42	74S	127	94+22	0474	31902.321	232321.71	A0	80+	109.6	4.6	-6.5	075881	-1.6	-1.2	0.7	256	39	39
7	08	17	34	D	7	Z02829	8.9	6		92	27S	129	142+23	0457	32739.862	233050.78	G0	82+	156.8	4.3	-6.3	075948	1.1	-2.9	-0.1	295	92	102
7	22	14	07	D	6	Z03447	7.5	40	-3	74	38N	137	32+25	0678	40655.071	254818.88	K0	87+	43.4	6.0	-6.1	076472	0.1	2.6	-0.0	87	92	-58
8	00	05	09	D	5	Z03485	8.5	61		53	72N	138	66+25	0682	41044.775	255832.03	F5	87+	77.5	5.7	-6.2	076500	-1.3	1.7	-0.4	107	123	-32
8	01	24	43	D	6	Z03508	7.6	74		54	59N	139	55+25	0685	41247.980	261115.71	G5	88+	65.5	5.5	-6.3	076514	-1.7	1.9	-0.0	138	91	-12
8	02	44	07	D	6	Z03528	8.1	76		53	64N	139	60+25	0690	41457.015	261726.06	K5	88+	70.8	5.2	-6.4	076530	-2.0	1.2	0.3	208	36	7
8	04	04	09	D	8	Z03551	8.7	64		72	48S	140	127+25	0698	41701.618	260459.16	F8	88+	137.8	5.0	-6.4	076543	-1.7	-3.0	0.2	248	73	27
8	04	20	17	D	6	Z03559	8.0	61		63	68S	140	108+25	0700	41739.693	261024.10	A0	88+	118.4	4.9	-6.4	076547	-1.7	-1.7	0.5	253	52	31
8	23	33	57	D	7	0773	6.9	45		84	24N	150	27+27	0734	50816.733	273128.37	F5	93+	33.1	6.0	-5.7	076998	0.1	3.5	0.0	88	89	-53
9	00	44	43	D	6	Z04214	8.9	58		82	45N	151	48+27	0737	51047.301	273424.12	K0	94+	54.0	5.8	-5.8	077030	-1.0	2.6	-0.3	100	108	-36
9	03	44	45	D	9	Z04279	8.7	77		82	34N	152	39+27	0746	51533.676	274415.94	F5	94+	43.9	5.7	-5.9	077080	-2.3	3.1	0.5	214	9	8
9	10	57	49	D	4	0833	7.1	1		93	50S	155	135+26	0835	53041.252	265751.50	B5	95+	138.9	4.5	-5.2	077237	0.9	-1.6	0.0	305	89	113
9	22	17	15	D	5	Z05422	8.5	20	-3	92	81S	162	111+27	0979	60442.247	270341.64	B8	97+	111.4	5.9	-4.9	077961	-0.4	0.7	-1.0	71	166	-85
9	23	13	49	D	8	0927	8.2	31		92	11N	162	24+27	0994	60612.109	272609.92	G0	98+	24.6	5.9	-4.9	078000	0.9	4.0	0.2	78	83	-71
9	23	36	06	D	5	Z05522	8.0	35		93	81N	162	94+27	1006	60739.882	271207.12	K0	98+	94.3	5.8	-4.9	078041	-0.7	1.1	-0.9	81	154	-66
10	00	52	26	D	6	0937	8.2	49		92	75S	163	118+27	1013	61030.161	270834.05	A0	98+	118.6	5.7	-5.0	078089	-1.7	-0.1	-0.9	92	180	-48
10	01	37	45	D	7	Z05615	8.5	58		92	37N	163	51+27	1019	61113.660	272633.50	F2	98+	51.3	5.6	-5.0	078108	-1.1	2.8	-0.3	100	111	-36
10	04	48	45	D	6	0958	6.7	76		94	71N	164	86+27	1054	61634.173	271329.27	K0	98+	85.6	4.9	-5.0	078196	-2.2	-0.1	0.2	219	52	10
10	05	33	08	D	6	Z05769	8.4	69		92	68S	164	127+27	1060	61730.734	270002.55	B9	98+	126.1	4.8	-5.0	078218	-1.5	-2.2	0.1	242	76	21
10	22	02	16	D	6	1068	6.9	7	0	93	66S	173	142+25	1542	70022.746	252809.25	A2	100+	137.8	5.5	-3.8	078990	-0.5	-0.4	-1.5	63	193	-102
10	22	46	39	D	6	Z06840	8.5	15	-8	92	69S	173	141+25	1557	70210.126	252753.21	K2	100+	136.8	5.5	-3.9	079025	-0.7	-0.4	-1.5	69	195	-91
10	22	37	24	D	4	Z06841	8.5	13	-6	92	75N	173	106+25	1558	70211.293	253539.15	G0	100+	101.5	5.5	-3.8	079026	-0.1	0.8	-0.9	68	159	-93
10	23	36	47	D	5	Z06880	8.6	24		92	81N	174	115+25	1570	70421.567	253256.51	A2	100+	109.7	5.4	-3.9	079052	-0.6	0.5	-1.1	76	171	-79
11	02	25	56	D	8	Z07012	8.5	55		92	77S	175	142+25	1598	70919.428	252231.64	A0	100+	136.3	5.1	-4.0	079137	-2.0	-1.7	-1.1	102	199	-38
12	02	37	20	R	5	Z08105	8.6	47		92	69N	173	285+22	1842	80140.645	223840.75	G5	100-	275.2	4.5	-2.7	079895	-1.4	0.5	-0.9	98	342	-47
12	04	36	14	R	6	1222	7.2	67		94	40N	172	315+22	1854	80454.258	223227.40	G0	100-	304.9	4.1	-2.7	079948	-1.8	-1.7	-0.6	131	355	-18

DAY D	TIME-UT H	M	S	P	AC D	USNO REF NO	MAX MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. D / //	SP	PCT SNLT	WA	LONG LIB	LAT LIB	SAO REF NO	A M/O	B M/O	C S/K	MN AZ	VA	HA
JANUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** JANUARY	** **	**	**	**	**	**	**	**	**	**	** JANUARY		
12	10	21	07	R	11	Z08311	8.5	31		92	44S	171	230+21	1795	81316.267	211007.83	A5	99-	21	8.6	3.1	-2.1	080039	-2.2	0.5	2.5	273	173	66
12	11	15	54	R	4	Z08341	7.5	21		93	45N	170	319+21	1803	81506.221	211915.48	G5	99-	30	6.2	3.0	-2.0	080063	0.2	-2.0	0.1	261	264	79
12	11	40	53	R	5	Z08360	8.5	17	-9	92	28N	170	337+21	1805	81613.147	211605.14	M0	99-	32	5.8	3.0	-1.9	080075	0.6	-2.3	-0.3	284	283	65
12	13	04	07	R	3	1250	5.9	2	6	92	70N	169	297+21	1817	81841.973	205023.57	G5	99-	28	5.6	3.0	-1.8	080112	0.5	-1.4	0.3	296	248	106
13	00	56	42	R	5	1322	6.1	17		95	69N	163	303+19	2110	84908.552	185625.42	A0	98-	28	9.5	3.8	-1.3	098162	-0.5	0.2	-1.1	79	357	-83
13	01	17	56	R	9	Z08995	8.4	21		92	25N	162	347+19	2113	85026.984	190011.79	K0	98-	33	2.6	3.8	-1.3	098182	-1.2	-2.7	-1.7	62	41	-78
13	05	26	10	R	9	1340	6.6	64		95	27N	161	346+18	2090	85642.248	182512.37	A0	97-	33	1.4	3.1	-1.2	098265	-1.0	-3.5	-0.9	136	19	-18
13	06	18	53	R	7	1343	6.6	69		95	40N	161	334+18	2093	85734.833	181451.45	M3	97-	31	9.1	2.9	-1.1	098276	-1.2	-2.7	-0.6	168	344	-5
13	09	10	46	R	8	Z09179	8.6	51		92	21N	160	354+18	2106	90133.453	174117.97	G0	97-	38	9.9	2.8	-0.8	098315	0.3	-3.5	-0.7	248	304	37
13	11	09	42	R	8	1355	7.6	29		93	15N	159	0+17	2007	90440.440	171340.85	G5	97-	35	4.4	2.1	-0.6	098362	0.9	-3.3	-1.1	269	306	66
14	02	22	35	R	5	Z09722	8.7	22		82	60N	151	319+14	2127	93851.854	140720.57	F2	94-	30	1.8	2.6	0.1	098703	-0.7	-0.5	-1.2	89	13	-73
14	03	45	28	R	6	Z09745	8.6	37		92	61S	150	260+14	2131	94040.051	133937.28	F5	94-	24	2.9	2.4	0.1	098726	-1.3	1.9	-0.9	103	312	-53
14	04	46	48	R	6	Z09761	7.2	48		84	83S	150	282+14	2134	94203.943	133426.77	K0	93-	26	4.8	2.2	0.2	098730	-1.7	0.5	-0.8	117	328	-38
14	04	14	56	R	8	Z09763	8.9	43		92	31N	150	348+14	2135	94209.231	135139.02		93-	33	0.6	2.3	0.2	098732	-1.0	-3.0	-1.3	109	38	-46
14	06	05	52	R	6	Z09782	8.9	60		92	77N	150	302+13	2150	94348.717	132418.89	G5	93-	28	4.8	2.0	0.3	098746	-1.8	-0.9	-0.7	142	332	-18
14	05	44	57	R	17	1437	8.9	57		92	6N	150	13+14	2139	94430.579	133457.79	F0	93-	35	5.9	2.0	0.3	098752	0.7	-7.4	-1.5	134	49	-24
14	07	45	44	R	6	Z09807	8.4	64		92	61N	149	319+13	2156	94553.490	130658.11		93-	30	1.1	1.6	0.5	098765	-1.4	-2.0	-0.4	193	308	6
14	09	16	27	R	6	Z09823	8.6	54		92	85S	149	285+13	2160	94719.816	123921.00	G5	93-	26	7.1	1.3	0.6	098778	-1.8	-1.4	0.4	232	247	28
15	02	38	55	R	5	1525	5.9	14		86	56N	140	327+09	2351	102345.426	85550.72	M0	88-	30	7.0	1.3	1.5	118256	-0.4	-0.8	-1.2	90	19	-79
15	02	46	41	RA	6	Z10311	7.7	15		94	48N	140	334+09	2352	102405.359	85519.53	F0	88-	34	1.8	1.3	1.5	118292	-0.5	-1.2	-1.3	91	27	-78
15	03	50	57	R	5	Z10327	8.8	27		82	65N	139	318+09	2356	102530.529	84022.82	K5	88-	29	8.4	1.2	1.6	118305	-0.8	-0.6	-1.2	101	9	-62
15	04	39	11	R	5	Z10346	8.5	36		83	80N	139	303+09	2358	102626.877	82738.92	K2	88-	28	2.9	1.1	1.6	118317	-1.2	-0.1	-1.1	111	350	-50
15	04	43	13	R	5	Z10349	9.2	37		82	67N	139	316+09	2359	102640.878	82927.61	F0	88-	29	6.0	1.1	1.6	118320	-1.1	-0.7	-1.1	111	3	-49
15	05	50	16	R	8	Z10365	8.6	48		92	61S	139	264+08	2368	102746.139	80327.95	A0	88-	24	4.7	0.9	1.7	118328	-2.3	1.5	-0.7	128	303	-32
15	06	07	03	R	6	1538	8.5	50		83	71N	139	312+08	2369	102821.173	81126.75	F8	88-	29	2.7	0.8	1.7	118334	-1.5	-1.0	-0.9	133	348	-28
15	06	31	04	R	6	Z10377	8.8	53		82	88N	139	295+08	2370	102838.350	80239.68	K2	88-	27	5.7	0.7	1.8	118337	-1.9	-0.4	-0.7	141	325	-22
15	09	38	30	R	7	Z10412	8.7	52		92	66S	138	270+07	2324	103153.906	71354.80	F2	87-	25	0.1	0.1	2.1	118358	-2.5	-0.9	0.6	220	239	24
15	10	44	04	R	5	1549	5.2	42		87	82N	137	301+07	2330	103319.112	70605.51	K0	87-	28	1.5	0.1	2.2	118376	-1.2	-1.9	0.2	239	259	40
15	10	49	35	R	15	Z10450	7.9	41		93	5N	137	18+07	2331	103436.061	71108.38	K0	87-	33	8.3	0.2	2.3	118389	1.8	-4.7	-2.6	240	335	41
15	11	58	52	R	7	Z10454	8.7	29	-5	92	55S	137	259+07	2333	103449.043	63719.76	G0	86-	28	3.9	0.3	2.3	118392	-1.4	-1.2	1.3	254	210	58
16	03	06	00	R	4	Z10859	8.8	8		73	78N	129	307+03	2462	110651.750	32058.82	K5	81-	28	5.4	0.0	2.9	118680	-0.2	0.1	-1.1	92	358	-82
16	03	06	31	R	5	Z10863	7.8	8		74	69N	129	316+03	2463	110658.882	32239.51	K0	81-	29	4.7	0.1	2.9	118683	-0.2	-0.3	-1.1	92	7	-82
16	05	27	58	R	6	Z10906	8.3	34		83	68S	128	273+03	2470	111035.870	24132.59	A3	81-	25	2.0	0.3	3.0	118712	-1.5	1.2	-1.0	118	317	-48
16	07	16	59	R	6	1624	6.8	49		85	75N	127	310+03	2475	111225.303	22529.46	F2	80-	28	6.4	0.7	3.2	118734	-1.5	-0.9	-0.9	147	335	-21
16	08	24	10	R	7	Z10960	8.5	53		83	56N	127	328+02	2403	111349.970	21312.30	K0	80-	30	7.2	0.9	3.3	118746	-1.2	-1.9	-0.8	173	334	-4
16	08	27	44	R	10	Z10973	8.9	53		92	24N	127	1+02	2406	111426.030	21434.55	F5	80-	33	9.8	1.0	3.4	118757	0.1	-3.4	-1.4	174	6	-4
16	09	39	55	RA	7	Z10975	8.9	51		83	72S	127	277+02	2408	111439.544	14434.63	F8	80-	25	5.3	1.2	3.5	118759	-2.5	-0.8	0.2	203	259	14
17	06	14	05	D	22	Z11490	8.3	30		94	-1S	117	204-02	3438	115348.146	-31703.84	F8	72-	182	1.1	1.8	4.4	138482	2.6	-9.0	-2.1	124	245	-46
17	06	32	37	R	23	Z11490	8.3	33		94	27S	117	232-02	3438	115348.146	-31703.84	F8	72-	210	0.0	1.8	4.4	138482	-5.1	8.4	0.0	128	270	-41
17	10	21	58	R	7	Z11547	8.3	45		74	48N	115	338-03	3217	115817.481	-34743.50	K5	72-	315	6.6	2.6	4.8	138523	-0.9	-2.3	-0.9	202	321	15

DAY D	TIME-UT H	M	S	P	AC D	USNO REF NO	MAX MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. D / //	SP	PCT SNLT	WA	LONG LIB	LAT LIB	SAO REF NO	A M/O	B M/O	C S/K	MN AZ	VA	HA
JANUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** JANUARY	** **	**	**	**	**	**	**	**	**	**	** JANUARY		
17	11	29	48	R	13	Z11555	8.6	38-11		94	39S	115	244-03	3218	115859.850	-42317.82	G5	71-	222	4.4	2.8	4.9	138527	-3.5	0.1	2.2	222	213	32
17	11	57	41	R	6	Z11561	9.0	34	-5	73	78S	115	283-03	3220	115927.878	-41939.19	K0	71-	261	3.2	2.9	4.9	138532	-1.7	-1.6	0.5	229	247	39
17	11	15	11	R	18	Z11568	9.4	40		92	5N	115	20-03	3223	115958.111	-35935.07	K0	71-	358	2.2	2.8	4.9	138537	1.8	-4.9	-3.4	218	352	28
17	11	31	30	R	10	1736	9.1	38-10		93	23N	115	3-03	3224	115958.403	-40220.63	K5	71-	340	5.2	2.9	4.9	138538	-0.6	-3.3	-1.7	222	331	32
18	05	39	15	R	7	1809	6.9	14		87	32N	106	353-07	3443	123552.430	-80834.46	A0	64-	330	8.3	5.0	5.4	138878	0.2	-2.1	-1.3	113	39	-64
18	07	13	35	R	5	Z12055	9.0	29		74	75N	106	310-07	3448	123720.814	-83658.75	F5	64-	287	9.9	3.2	5.5	138888	-1.0	-0.3	-1.1	132	346	-41
18	09	14	34	R	6	Z12086	8.0	41		75	73N	105	311-08	3401	123939.796	-90518.26	MA	63-	289	6.3	3.6	5.7	138911	-1.5	-1.0	-0.9	165	323	-11
18	10	34	05	R	7	Z12109	9.0	41		74	48N	104	336-08	3409	124125.353	-91924.39	K0	63-	314	4.4	3.9	5.9	138925	-1.0	-2.0	-1.1	191	328	8
18	11	40	13	R	6	Z12122	7.6	36	-9	76	69N	104	315-08	3413	124219.367	-93642.73	F0	62-	293	5.5	4.1	5.9	138935	-1.5	-1.8	-0.4	211	291	25
18	11	56	09	R	9	Z12123	9.3	34	-6	83	54S	104	259-09	3542	124220.705	-95337.48	F2	62-	236	9.4	4.1	6.0	138936	-2.7	-0.7	1.1	215	232	29
19	07	07	42	R	15	Z12689	8.5	18		95	6N	94	16-13	3697	132233.652	-134418.49	F5	54-	355	3.3	4.3	6.4	157914	1.9	-5.4	-1.9	126	57	-53
19	07	54	35	R	6	Z12694	8.6	25		75	52N	94	330-13	3699	132249.494	-135706.38	F5	54-	309	0.4	4.4	6.4	157917	-0.5	-0.9	-1.3	135	4	-41
19	09	52	13	R	8	Z12718	9.0	35		84	62S	94	265-14	3721	132441.991	-143838.81	G5	53-	243	8.4	4.7	6.6	157933	-2.9	0.7	-0.2	166	276	-12
20	07	22	59	R	6	Z13402	8.7	10		85	46N	83	334-18	3761	140905.077	-183550.03	F2	44-	314	6.5	5.2	7.0	158398	0.0	-0.8	-1.3	124	17	-60
20	07	56	23	R	7	Z13408	8.6	15		85	58S	83	258-18	3763	140923.619	-190033.95	G5	44-	238	6.5	5.2	7.0	158404	-1.7	2.0	-0.7	130	297	-51
20	08	18	52	R	5	Z13418	7.9	18		77	70N	83	309-18	3766	141010.167	-185259.17	K0	44-	290	1.5	5.3	7.0	158414	-0.7	-0.1	-1.2	134	345	-46
20	10	50	18	D	25	Z13468	9.2	31		95	1S	82	200-19	3840	141401.716	-194918.02	G5	43-	181	0.5	5.8	7.3	158450	3.5	-6.1	-4.8	170	208	-9
20	11	10	21	R	25	Z13468	9.2	31		95	28S	82	227-19	3840	141401.716	-194918.02	G5	43-	207	8.5	5.8	7.3	158450	-6.8	4.5	3.5	176	230	-4
21	07	33	11	R	7	Z14187	8.1	1		92	51S	72	246-2210782		145920.492	-230403.91	G5	34-	229	7.5	5.8	7.3	183083	-1.2	2.5	-0.7	121	292	-69
21	08	28	42	R	5	Z14219	8.7	10		75	65N	71	309-2210798		150109.665	-230011.89	K0	34-	293	3.5	5.9	7.3	183114	-0.4	0.1	-1.2	130	350	-55
21	08	43	52	R	5	Z14225	9.1	12		75	84N	71	291-2210800		150124.753	-230742.69	K5	34-	274	8.5	5.9	7.4	183122	-0.8	0.6	-1.0	133	329	-51
21	09	10	36	R	7	Z14231	8.9	15		85	63S	71	257-2210808		150206.162	-232159.18	K5	34-	241	7.6	5.9	7.4	183135	-1.8	1.7	-0.6	138	292	-45
21	09	11	17	R	12	Z14249	9.4	15		95	11N	71	3-22	3894	150316.513	-230328.46	F0	34-	347	6.6	6.0	7.4	183150	1.3	-3.1	-2.2	138	38	-45
21	09	14	42	R	12	Z14251	9.5	16		95	11N	71	3-2210818		150321.712	-230410.04	F0	34-	347	3.6	6.0	7.4	183151	1.3	-3.0	-2.2	138	37	-44
21	09	49	00	M	**	Z14255	8.3	19		96	15S	71	209-2312049		150339.001	-231956.97	K0	34-	193	4.6	6.1	7.5	183157	**********			146	238	-36
GRAZING OCCULTATION OF Z14255 NEARBY -- APPROXIMATE SOUTHERN LIMIT -- LAT. = 39.26 + 0.75(WEST LONG. - 77.07).																												
21	10	15	09	R	7	Z14261	9.5	22		85	65S	71	259-2312052		150345.819	-233422.75	F8	34-	243	0.6	6.1	7.5	183159	-2.3	1.3	-0.4	151	283	-29
21	09	58	07	R	12	Z14270	7.1	20		98	10N	71	4-22	3901	150430.650	-231246.43	F2	34-	348	2.6	6.1	7.5	183171	1.3	-3.1	-2.5	147	31	-34
21	11	05	43	R	6	Z14281	8.8	26		76	79S	70	273-2312062		150458.108	-233935.55	G0	33-	257	7.6	6.3	7.6	183181	-2.2	0.5	-0.4	163	288	-17
21	11	04	48	R	6	Z14287	8.8	26		76	66N	70	308-2312063		150510.869	-233051.19	G5	33-	292	3.6	6.3	7.6	183185	-1.4	-0.4	-1.0	163	323	-17
22	08	36	31	RA	8	2287	3.0	1		99	16N	59	352-2511228		155705.758	-260159.89	B2	25-	340	4.4	6.1	7.3	183987	1.1	-2.1	-1.7	125	38	-66
22	09	14	23	R	6	Z15239	8.3	6		94	59S	59	247-2611137		155726.137	-263010.76	A2	24-	235	5.5	6.1	7.4	183993	-1.5	2.1	-0.5	131	288	-57
22	09	59	37	R	6	Z15259	8.7	12		86	73S	59	261-2611146		155845.300	-263419.28	K2	24-	249	3.6	6.2	7.4	184016	-1.6	1.4	-0.6	139	296	-46
22	09	52	39	R	5	Z15262	9.0	11		85	48N	59	320-2611150		155857.320	-261842.17	G0	24-	308	8.8	6.2	7.4	184017	-0.4	-0.2	-1.4	138	356	-48
22	11	21	18	R	6	Z15308	8.4	20-12		86	52N	58	315-2611170		160124.359	-263307.69	A0	24-	304	0.0	6.4	7.5	184062	-1.1	-0.3	-1.3	155	337	-26
22	11	32	25	R	5	2297	6.9	21-10		88	69N	58	299-2611171		160130.109	-263816.35	F8	24-	287	3.6	6.5	7.5	184064	-1.5	0.0	-1.0	158	318	-23
22	11	51	12	R	8	Z15318	8.9	22	-6	95	57S	58	244-2611177		160158.612	-265502.46	F5	24-	232	9.6	6.5	7.6	184074	-2.7	1.4	0.3	162	260	-19
22	12	08	37	R	9	Z15336	9.2	23	-3	92	26N	58	341-2611192		160306.717	-263534.36	G0	24-	337	0.0	6.6	7.6	184088	-0.7	-1.5	-2.2	166	353	-14
23	10	02	33	G	**	Z16269	7.6	3		93	14S	46	195-2812708		165913.742	-283046.34	K0	16-	186	4.0	6.0	7.0	184914	**********			131	237	-59
GRAZING OCCULTATION OF Z16269 NEARBY -- APPROXIMATE SOUTHERN LIMIT -- LAT. = 39.00 + 0.63(WEST LONG. - 77.07).																												

IV.. CHRONOLOGICAL PLEIADES PREDICTIONS

Following the Pleiades predictions (if any) are abridged data in chronological order for the convenience of the observer. Under "REMARKS" the comments "NO CHU" and "NO WWV" (for Western Hemisphere observers only) appear when the predicted time indicates that either or both time transmissions would possibly not be usable for eye-and-ear timings. This happens if the predicted time plus or minus the accuracy of overlaps a "silent" period for the time signals. Other comments which may appear are "Double", "GRAZE," MISS", or notes about the altitude of the Sun "SUN" or the star "ALT".

DAY D	TIME-UT H	M	S	P D	AC	USNO REF NO	MAX MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. O / //	SP	PCT SNLT	WA	LONG LAT LIB LIB	SAO REF NO	A M/O	B M/O	C S/K	MN M/	VA	HA
JANUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** JANUARY	** **	**	**	**	** **	**	**	**	**	**	JANUARY	
23	10	22	58	RA	6	Z16275	9.3	6		82	42N	46	319-2711376		165926.832	-280558.18	F8	16-	212.6	7.1	184949	1.4	0.9	0.5	144	327	-41
23	11	16	32	R	5	Z16309	9.0	13		85	85N	46	275-2812738		170047.508	-282208.31	B9	15-	263.2	6.1	184949	1.4	0.9	0.5	144	327	-41
23	11	32	07	R	5	Z16315	9.2	14	-10	85	89S	46	270-2812749		170116.351	-282509.60	A0	15-	263.7	6.1	184954	1.5	0.9	0.6	147	299	-37
23	11	44	11	R	7	Z16340	7.8	16	-8	97	35N	46	326-2812760		170209.893	-281306.59	B9	15-	319.5	6.2	184978	0.6	0.5	1.7	149	353	-34
23	12	16	05	R	6	2453	6.7	18	-2	85	76S	46	257-2812769		170237.912	-283232.87	G5	15-	250.6	6.3	184990	2.0	1.0	0.2	156	278	-27
24	11	41	12	R	6	Z17928	9.2	8	-8	93	66S	33	238-2814139		180437.272	-283400.88	B8	8-	237.5	5.4	186278	1.6	1.9	0.1	137	275	-50
24	11	47	34	R	5	Z17932	8.2	9	-7	95	74S	33	246-2814143		180445.572	-283217.26	K0	8-	245.4	5.4	186281	1.5	1.6	0.3	138	282	-48
24	11	54	41	R	5	Z17938	7.3	10	-5	97	69N	33	283-2814144		180455.441	-282209.96	A0	8-	283.2	5.5	186286	1.1	0.8	0.9	140	318	-46
24	12	35	39	R	5	2617	4.7	15	2	96	85N	33	267-2814174		180614.536	-282748.97	K0	8-	266.7	5.5	186328	1.6	1.6	0.5	147	295	-37
25	12	09	01	D	24	Z19901	9.1	5	-3	92	5S	20	165-2713671		191041.110	-265047.44	K0	3-	171.4	4.3	187813	2.3	4.7	5.8	130	207	-58
GRAZING OCCULTATION OF Z19901 NEARBY -- APPROXIMATE SOUTHERN LIMIT -- LAT. = 38.42 + 0.53(WEST LONG. - 77.07).																											
27	15	56	47	D	5	3126	4.3	27	29	93	51N	10	41-17	6245	212037.820	-165738.77	K0	1+	57.0	1.5	1.7	164346	1.3	1.7	0.5	146	68	-32
28	23	10	56	D	4	Z24070	8.6	16	-9	86	57N	27	34-09	5988	222824.439	-83407.45	G0	6+	53.7	0.6	1.0	146122	0.3	0.6	1.1	244	348	61
29	00	12	55	D	4	Z24105	9.1	6		82	77S	28	80-09	5996	223054.656	-82555.06	A2	6+	100.3	0.6	1.1	146141	0.3	0.9	0.9	255	31	76
29	23	09	26	D	7	Z24818	9.0	30	-9	85	24N	41	358-02	5944	232114.590	-13751.84	F8	12+	20.2	1.2	2.6	146674	0.1	2.9	1.3	240	316	49
29	23	40	46	D	6	Z24831	9.1	25		85	32N	41	6-02	5947	232216.443	-12842.02	M5	13+	27.8	1.1	2.7	146684	0.1	2.2	1.2	246	320	56
29	23	44	13	D	12	Z24842	7.8	24		97	28S	41	126-02	5951	232309.276	-15402.69	G5	13+	148.3	1.1	2.7	146693	2.2	5.3	0.5	246	81	57
30	01	24	25	D	5	Z24867	9.3	6		82	37N	42	11-01	4438	232538.883	-5830.90	K2	13+	33.2	1.1	2.9	146711	0.0	1.7	1.1	264	320	81
30	01	49	31	DA	3	Z24885	7.8	2		62	88N	43	62-01	4440	232717.151	-5941.62	F8	13+	84.3	1.1	2.9	146725	0.0	0.3	0.9	267	11	87
31	00	45	37	D	4	Z00216	9.2	27		55	74S	56	81+04	0030	1731.996	52829.34	K2	22+	103.1	2.7	4.3	109132	0.9	0.9	0.9	254	32	60
31	01	03	02	D	4	0039	9.0	24		45	84S	56	70+04	0032	1759.932	53601.76	K5	22+	92.4	2.7	4.3	109139	0.7	0.5	1.0	257	20	64
31	01	47	30	D	4	Z00243	8.7	16		46	86S	56	68+05	0036	1922.763	54807.68	G5	22+	90.5	2.6	4.4	109155	0.4	0.5	1.0	265	17	75
31	02	16	52	D	5	Z00257	8.7	10		75	43S	56	111+05	0040	2021.770	54334.77	K0	22+	133.8	2.6	4.4	109161	0.2	2.4	0.7	269	60	82
31	23	38	30	D	5	Z01000	8.3	51		46	50N	69	26+11	0152	10743.674	115235.84	F2	32+	47.8	4.2	5.4	092279	1.0	1.8	0.9	234	346	31
FEBRUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** FEBRUARY	** **	**	**	**	** **	**	**	**	**	**	FEBRUARY	
1	01	04	11	D	5	Z01027	8.7	37		46	54N	69	30+11	0157	11003.823	121137.08	G0	32+	51.5	4.0	5.5	092305	0.9	1.3	1.1	255	339	52
1	01	15	13	D	4	0177	7.1	35		28	85N	69	61+11	0158	11047.947	120748.89	F5	33+	82.7	4.0	5.5	092310	1.0	1.0	1.0	256	10	55
1	01	56	41	D	9	Z01054	9.1	27		85	28S	70	128+00	0000	11156.244	115850.62		33+	149.7	3.9	5.5	092319	0.8	4.4	0.5	264	76	65
2	00	58	37	D	7	0304	8.6	51		56	45S	82	114+16	0237	20408.735	173054.33	F8	44+	134.0	5.1	6.2	C92787	1.9	2.7	0.5	248	65	38
2	02	08	29	D	4	0311	6.5	38		08	85S	83	75+17	0315	20610.928	175341.18	A3	44+	94.7	5.0	6.2	092801	1.1	0.6	0.9	263	21	55
2	23	17	13	D	8	Z02454	8.4	73	-9	55	52S	95	112+21	0396	25712.737	215334.16	A5	54+	128.6	6.2	6.5	075670	2.9	1.4	0.2	181	111	0
3	01	02	15	D	8	Z02485	8.6	62		64	42S	95	122+21	0400	25947.497	220655.04	G5	55+	138.4	5.9	6.6	075686	2.2	3.1	0.3	241	74	26
3	01	34	21	D	6	Z02497	8.2	57		35	61S	96	103+21	0403	30047.780	221549.58	F5	55+	119.7	5.8	6.6	075699	1.8	1.6	0.6	250	51	34
3	03	20	24	D	5	Z02530	8.9	37		24	70N	96	54+22	0430	30344.272	224018.53	K2	56+	70.3	5.5	6.6	075722	1.2	0.1	1.1	271	356	60
3	04	26	19	D	6	Z02557	8.8	25		54	40S	97	124+22	0438	30558.853	222754.83	G5	56+	140.6	5.5	6.5	075741	0.0	2.7	0.5	280	68	76
3	04	35	53	D	4	Z02563	9.1	23		24	58S	97	107+22	0441	30628.622	223309.95	F0	56+	122.7	5.4	6.5	075746	0.2	1.8	0.7	281	51	78
3	06	12	49	D	4	Z02620	8.9	6		53	64N	98	49+22	0450	31001.365	225551.97	K0	57+	64.8	5.4	6.4	075782	0.2	0.1	1.1	295	359	101
3	06	13	48	D	4	Z02622	9.3	6		52	68N	98	53+22	0451	31006.682	225508.04	K7	57+	68.6	5.4	6.4	075784	0.1	0.2	1.1	295	3	102
3	06	23	19	D	3	Z02631	8.6	4		32	76S	98	89+22	0453	31044.651	224631.78	G0	57+	105.2	5.4	6.4	075790	0.3	1.0	0.7	296	40	104
3	17	31	40	D	3	0539	4.4	10	35	12	86S	105	82+24	0547	34330.072	242251.56	B5	63+	95.5	7.2	6.0	076140	0.2	1.2	0.6	67	134	-97

DAY D	TIME-UT H	M	S	P D	AC	USNO REF NO	MAX MAG	MN AL	SN AL	O V	CA	ELG	PA	DM REF NO	RT. ASC. H M S	DECL. O / //	SP	PCT SNLT	WA	LONG LAT LIB LIB	SAO REF NO	A M/O	B M/O	C S/K	MN M/	VA	HA
FEBRUARY	**	**	**	**	**	**	**	**	**	**	**	**	**	**	** FEBRUARY	** **	**	**	**	** **	**	**	**	**	**	FEBRUARY	
3	17	49	59	D	5	0541	4.0	13	34	63	50S	105	118+23	0516	34407.184	241654.13	B5	63+	131.8	7.2	6.0	076155	0.3	0.6	1.3	69	172	-92
3	18	26	07	R	5	0541	4.0	20	33	62	32S	105	201+23	0516	34407.184	241654.13	B5	63+	213.7	7.2	6.1	076155	0.7	2.5	0.3	74	256	-83
3	23	45	16	D	12	Z03272	9.4	76		83	20N	107	10+25	0644	35429.044	254054.56	G0	65+	22.2	6.6	6.5	076329	0.6	5.6	0.7	158	29	-6
4	01	12	49	D	8	Z03310	9.2	72		53	40N	108	30+25	0650	35709.035	254747.45	A2	65+	42.7	6.3	6.6	076363	1.8	3.0	0.7	229	349	15
4	01	07	39	D	7	Z03311	9.1	72		43	49N	108	39+25	0649	35739.934	254556.13	A2	65+	51.7	6.3	6.5	076364	1.9	2.3	0.6	226	0	14
4	02	21	33	D	6	Z03345	9.4	60		23	70N	108	60+25	0660	35926.476	254649.17	G0	66+	72.6	6.1	6.5	076391	1.9	0.5	0.8	254	4	32
4	02	52	01	D	6	0597	8.9	55		44	60N	108	50+25	0662	40011.384	255050.29	K2	66+	62.0	6.0	6.5	076400	1.8	0.9	0.9	260	351	40
4	03	03	05	D	6	Z03359	8.6	52		34	63N	109	54+25	0663	40033.694	255033.25	G5	66+	65.7	6.0	6.5	076405	1.7	0.6	0.9	262	354	42
4	03	15	49	D	6	Z03363	8.1	50		35	65N	109	55+25	0664	40057.673	255044.09	A0	66+	67.3	5.9	6.5	076407	1.7	0.4	1.0	265	356	45
4	05	13	42	M	**	Z03402	8.3	28		94	8N	109	358+25	0673	40351.694	260051.89	A0	67+	9.9	5.7	6.4	076443	**********			282	300	74
GRAZING OCCULTATION OF Z03402 NEARBY -- APPROXIMATE NORTHERN LIMIT -- LAT. = 38.64 + 0.41(WEST LONG. - 77.07).																											
4	04	51	15	D	5	Z03410	9.0	32		13	74S	109	96+25	0674	40415.236	254251.42	G5	67+	108.1	5.8	6.4	076447	0.5	1.4	0.8	279	38	68
4	05	13	24	D	5	Z03425	8.2	28		24	58S	109	113+25	0677	40457.438	253854.82	A0	67+	124.5	5.7	6.4	076460	0.2	1.9	0.6	282	55	74
4	06	03	30	D	4	Z03447	7.5	19		45	89N	110	80+25	0678	40654.810	254818.97	K0	67+	91.7	5.7	6.3	076472	0.2	0.9	0.9	288	25	86
4	23	39	34	D	7	Z04000	7.5	69		55	61S	120	115+26	0764	45348.343	270938.67	K0	75+	122.6	6.8	6.1	076841	2.4	0.7	0.6	117	167	-21
5	00	54	14	D	7	Z04021	8.7	78		23	84S	120	93+27	0712	45554.004	272009.34	F5	75+	100.1	6.5	6.1	076857	2.3	0.0	0.1	167	104	-3
5	02	21	52	DA	6	0746	6.8	71		36	63S	121	114+27	0716	45807.045	271711.97	B9	75+	120.7	6.2	6.1	076880	2.0	1.8	0.2	238	65	18
5	05	16	15	D	12	Z04102	9.3	38		82	15S	121	162+26	0778	50235.275	270520.45	K0	76+	168.9	5.7	5.9	076936	1.2	5.4	0.5	276	102	61
5	07	09	37	D	4	Z04161	9.0	18		53	86N	122	83+27	0731	50732.488	271558.45	K2	77+	89.4	5.6	5.7	076984	0.1	1.0	0.9	291	28	88
5	23	05	29	D	5	Z05043	9.1	53	-7	42	72N	131	74+27	0897	55123.230	273717.01	F5	83+	76.4	6.7	5.3	077671	1.2	1.7	0.6	94	136	-43
5	23	10	08	DA	5	0890	4.5	53	-7	49	75N	131	78+27	0899	55132.486	273633.91	A0	83+	79.9	6.7	5.3	077675	1.3	1.5	0.6	95	139	-42
5	23	21	36	D	6	Z05062	9.0	56	-10	42	85S	131	98+27	0900	55153.447	273136.07	F5	83+	100.0	6.7	5.3	077686	1.7	0.7	0.7	97	159	-39
6	00	45	24	D	33	Z05090	8.0	71		94	14S	132	169+27	0906	55316.842	272025.90	F5	83+	170.3	6.4	5.4	077711	**********			121	217	-19
GRAZING OCCULTATION OF Z05090 NEARBY -- APPROXIMATE SOUTHERN LIMIT -- LAT. = 38.65 - 0.13(WEST LONG. - 77.07).																											
6	00	38	03	D	7	Z05109	7.5	70		54	59N	132	62+27	0914	55353.011	274252.16	B2	83+	63.7	6.4	5.4	077724	1.8	2.0	0.2	117	114	-21
6	01	26	45	D	6	Z05147	8.9	77		42	85N	132	88+27	0922	55517.810	273601.90	K2	84+	90.0	6.3	5.4	077752	2.2	0.4	0.2	145	119	-9
6	01	55	47	D	10	Z05154	9.1	78		72	37S	132	146+27	0925	55531.546	272212.44	F5	84+	148.0	6.2	5.4	077758	2.1	3.8	0.5	174	152	-1
6	02	34	26	D	10	Z05187	9.1	77		82	39N	132	43+27	0932	55640.245	274517.91	A2	84+	44.6	6.0	5.4	077783	2.7	3.1	0.6	213	14	8
6	02	38	27	D	6	Z05204	8.3	77		43	76N	133	79+27	0935	55707.434	273644.99	B9	84+	80.7	6.0	5.4	077798	2.3	0.3	0.3	216	48	9
6	03	14	36	D	58	Z05207	9.0	71		92	11N	133	15+27	0936	55713.078	274706.89	G0	84+	16.1	5.9	5.3	077801	**********			239	326	18
GRAZING OCCULTATION OF Z05207 NEARBY -- APPROXIMATE NORTHERN LIMIT -- LAT. = 39.31 + 0.24(WEST LONG. - 77.07).																											
6	02	44	45	D	6	Z05210	7.6	76		44	86N	133	89+27	0938	55718.454	273347.07	B9P	84+	90.7	6.0	5.3	077804	2.2	2.0	0.2	220	54	10
6	02	48	00	D	6	Z05215	9.0	75		42	83N	133	86+27	0940	55723.381	273428.57	A0	84+	87.7	6.0	5.3	077806	2.2	2.0	0.2	223	49	11
6	03	46	52	D	9	0906	6.8	66		75	31S	133	153+27	0943	55819.185	271628.79	K0	84+	154.0	5.8	5.3	077819	0.8	4.3	0.1	249	97	26
6	03	59	21	DA	6	0909	6.1	64		56	67N	133	71+27	0945	55913.342	273429.73	B8P	84+	72.0	5.7	5.3	077837	2.2	0.1	0.7	253	13	29
6	04	19	43	D	7	Z05274	9.1	60		62	49S	133	134+27	0948	55931.346	271705.72	G0	84+	135.5	5.7	5.3	077845	1.0	2.8	0.2	258	75	34
6	04	51	54	D	7	Z05301	9.0	54		62	39S	133	145+27	0955	60016.843	271236.10	G0	84+	145.9	5.6	5.2	077864	0.5	3.3	0.1	264	84	42
6	04	47	02	D	5	Z05308	9.1	55		52	74N	133	78+27	0958	60036.263	272848.51	A2	84+	79.4	5.6	5.2	077870	1.7	0.6	0.8	263	17	40
6	04	52	24	D	5	Z05314	9.1	54		42	89N	133	93+27	0959	60047.326	272429.09	G5	84+	93.8	5.6	5.2	077874	1.4	1.1	0.7	264	32	42
6	05	12	14	D	6	Z05328	9.2	50		52	74N	133	78+27	0962	60120.694	272639.93	A5	84+	78.8	5.5	5.2	077886	1.6	0.7	0.9	268	16	46

U.S. Naval Observatory Occultation Predictions

I. Page Headings: First is observability code limit, specified by observer, used to select events to be printed Only events rated at the given limit or higher appear on the predictions.
Second - is inactive if O; otherwise , it is the quarter of the year in which the next years predictions are to be mailed to the observer. when an early mailing is needed.
Third - is 1 for photoelectric options, 4 for extended radius for "graze nearby" messages.
Fourth - is inactive.
ADDRESS CODE begins with letter A, containing five characters and identifies observers name and mailing address to USNO.
STATION CODE begins with letter S or P , contains five characters, and identifies station name and geodetic coordinates.
YEAR, STATION NAME AND APPROXIMATE COORDINATES. also appear on second line of page heading.

II. Column Headings

DAY TIME -UT (D H M S) give the day of themonth and hours, minutes and seconds of predicted Universal Time (UT) of occultation event.

P is phenomenon: D for disappearance, R for reappearance, G for graze (given time for central graze; multiple events may be expected up to five minutes before or after) M is for miss (line appears only because of graze nearby line which follows).

D is double star code: N, S, P, F mean prediction is for only the north, south, preceeding (West) or following (East) conponent of the double. M means double was unresolved photographically, and prediction is for mean position of components. A, I, etc. refer the observer to a double star catologue for detail (A is Aitken, I is Innes, etc.)

AC is estimated accuracy of prediction, in seconds. Prediction may be in error because of limb irregularities and star position and uncertainties, but by normore than the amount in this column for almost all cases. Regular errors of larger size usually indicate a problem with the station coordinates. Please confer with USNO if this occurs.

USNO REF NO is the primary identification of the star, needed on the observation report. Four digit reference numbers are from the zodiacal catalog of Robertson (ZC) Five digit numbers preceeded by the letter Z are from the USNO subset of the Smithsonian Star Catalog for the zodiacal regions of the sky (SZ). Other letters designate special catalogs -- eg. P for Pleiades.

MAX MAG is the visual magnitude of the star. For variables it is the maximum magnitude.

MN AL is the altitude of the Moon above the horizon. This and all subsequent quantities are in degrees, unless other units are specifically indicated.

SN AL is the altitude of the Sun, given only when it is greater than or equal to -12 degrees (which is the end of nautical twilight). Daytime events are also predicted when observable.

V is the estimated relative value of the event for reduction purposes, with 9 being the highest value. The code approximately indicates that the most valuable events during the reductions are reappearances, events near new or full moon, near grazes and stars with southern declinations. It is planned to discontinue listing this code on future predictions.

O is the observability code, with 9 the most easily observed. and 0 meaning not observable under any condition Only events rated at the observers selected observability code limit or higher appear on the predictions.

CA is the cusp angle of the event. This is the angle from the nearest lunar cusp to the star. The nearest cusp is identified by letter as the North (N), South (S), East(E), or West(W), cusp. Cusp angles are positive on the dark limb and negative on the bright limb.

ELG is the elongation of the moon from the sun. This is the angle at the center of the Earth between the Sun and the Moon. It can never exceed 180 degrees and is O degrees or 180 degrees only at the time of an eclipse.

PA is the posttion angle of the event, measured at the center of the Moon's disk from the north celestial pole eastward to the star.

DM REF NO is the Durchmusterung reference number. For BD numbers, the zone and four digit numbers are separated by a blank. For CD numbers, the zone and five digit numbers are unseparated.

RT ASC (H M S) is the accurate apparent right ascention of the star at the time of occultation.

DECL (0 / //) is the accurate apparent declination of the star at occultation

SP is the star's spectral type. For bright limb events, type G stars have the same color as moonlight, and are the most difficult to resolve. Stars with more than one spect rum (specturm variables, double-line spectroscopic binaries) have for spectral type.

PCT SNLT is the percent of the moon's disk sunlit (100% is full moon) followed by plus for waxing and minus for waning.

WA is the Watts angle of the event, measured at the center of the moon's disk from the Moon's north rotation pole eastward to the star. It is different from the axis angle only intthat a correction of plus 0.22 degrees has been added so ahthat the angle can be used directly for limb correction look up in the Watts charts.

LONG LIB is the moon's topocentric libration in longitude.

Lat

LAT LIB is the moon's topocentric libration in latitude.

SAO REF NO is the reference number of the star in the Smithsonian Astrophysical Observatory (SAO) catalog. O or blank indicates a star not in the SAO catalog.

*A B C (M/0 M/0 S/K) are the rate s of change of the predicted occultation time with changes in the observers longitude, latitude and elevation, respectively. The units are minutes of time, per degree of longitude or latitude (M/0) and seconds of time per kilometer (S/K). If the event is so near grazing that these quantities become useless, asterisks appear instead.

*MN AZ is the azimuth of the Moon, measured along the horizon from the north point eastward.

*VA is the vertex angle of the event, measured at the center of the Moon's disk from the zenith eastward to the star.

*HA is the hour angle of the moon, measured at the north celestial pole from the observers meridian westward (positive) or eastward (negative) to the star.

* These quantities are not given for photoelectric option preditions. Instead the following data is given.

RAD RATE (AS/A) is the topocentric radial rate of approach of the star to the Moon's limb, in arc seconds per second of time.

DIST (KM) is the topocentric distance of the Moon's center from the observer, in kilometers. The moon's mean distance is 384,400 km. The ratio of mena to true distance is the factor to be applied to Watts limb corrections to refer them to true distance. The factor distance divided by 206265 may be used to convert radial rate into kilometers per second.

CNT ANGL is the contact angle of the star with the Moon's mean circular limb. It is 0 degrees for central disappearance, 90° for grazes and 180° for central reappearances.

HA (0 /) is the hour angle of the Moon, the same as for non-photoelectric option predictions, but given in degrees and minutes of arc.

III. Supplementary Information Lines

"GRAZING OCCULTATION OF ..... NEARBY...." draws the observers attention to a nearby grazing occultation of the preceeding star on the predictions, usually within 20 to 40 miles (50 to 100 miles for the extended graze option). Ordinarily, multiple occultations will not occur at the observers station unless the phenomenon for the star was "G", and possibly not even then. The approximate location fo the graze limit lines may be drawn on a mapwith the aid of the folmula in the meg message.
lines may be drawn on a map with the aid of a formula in the message. By substituting various values for "West Long." into the formula, one can compute the corresponding latitude of a point in the limit.

"POSSIBLE LUNAR ECLIPSE" indicates that the usual testing of the magnitude of stars to determine observability codes has been temporarily suspended because the Moon may be in eclipse at the time.

"ABOVE STAR... IS A VARIABLE STAR..." gives the minimum magnitude for variable stars. If the minimum is unknown (usually very faint) the value 99.9 may appear.

"TRIGONOMETRIC STELLAR PARALLAX OF ABOVE STAR..." gives the parallax from the Yale Catalog in seconds of arc, when it is at least 0".015. This message appears only on predictions with photoelectric options.

MONTH of the year appears on a separate line immediately following the headings on each page, and again whenever it changes.

OCCULTATION PROJECTS NOTICE

This notice contains information about changes in proceedure for all active participants in occultation projects. Observers should take particular note of Section II.

I. Reasons for Changes : The occultation projects of both the Nautical Almanace Office, U.S. Naval Observatory, Washington (USNO) and Her Majesty's Nautical Almanac Office, Royal Greenwich Observatory, Hertstmonceux (HMNAO), are now being fully coordinated. This has led to a number of procedural changes in each office, primarily to avoid duplication of effort and to maximize the amount of scientific data obtained from occultation observations.

II. REPORTS OF OBSERVATIONS -- TOTALS AND GRAZES: Effective immediately, all reports of occultation observations, wheter totals (ordinary occultations) or grazes, should be sent to Mrs. F.M. Sadler at HMNAO. No copies should be sent to USNO. All observers are requested to use the standard report forms for tatals to speed up keypunching and processing of of the observation reports. Analogous forms are being prepared for grazes, and will be distributed when available with appropriate instructions. North American Observers are encouraged to send their observation reports, at least of grazes, to HMNAO via air mail. The current rate for air mail from the United States to England is 20¢ per half ounce.

Both USNO reference numbers (same as Z.C. number for Z.C. stars) and the SAO number should be reported for both total and grazing occultations when given in the predi ctions.

III. 1971 PREDICTIONS -- TOTALS : Both USNO and HMNAO will continue to supply predictions in 1971 on essentially the same basis as in 1970. It is hoped to merge these two efforts in time for the 1972 predictions. See separate descriptions of format changes in the USNO predictions.

IV. 1971 PREDICTIONS -- GRAZES : It is not known to what extent USNO graze predictions will be available during 1971. Perhaps only to the US, Canada and some other selected locations can be covered in 1971. The HMNAO predictions, however, are more widely available and include computer produced profiles when needed. Graze maps for inclusion in a few widely distributed profiles
distributed publications are being prepared at HMNAO.

V. PRELIMINARY REDUCTIONS -- TOTALS : Only HMNAO will supply observers with preliminary reductions. Generally Non-ZC stars will also be reduced i in the same manner as ZC stars. Observers are advised that the residuals. canain the effects of errors in the preliminary lunar emphemeris, star positions, limb corrections, etc. Star positions for non-ZC stars are especi ally poor. However if a large percenta ge of residuals are in excess of 1."5, an error in the observer's coordinates or in the timing proceedure is usually indicated.

VI. PRILIMINARY REDUCTIONS --GRAZES: Preliminary reduction profiles for many grazing occultations preparted by Ronald Abileah (U. of Miss., Kansas City) were distributed to the observers invol ved during the past year. The preparation of the machine data for all other graze observations which have been reported is nearing completion. With the help of the Watts chart in machine-readable form (see section VIII) Mr. Abileah hopes that the preliminary reduction profiles for all these grazes can be produced by machine and distributed to observers in 1971.

Reprints of an article, "On the Orientation of C.B. Watts' Charts of the Marginal Zone of the Moon", published in MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, can be obtained upon request to the author, L.V. Morrison, HMNAO. The study is based primarily on graze observations and details one area where such observations are used.