DARK SKIES for December 2020:

T/W Dec.	1/2	none
W/T Dec.	2/3	6:08 p.m. - 6:16 p.m.
T/F Dec.	3/4	6:07 p.m. - 7:13 p.m.
F/S Dec.	4/5	6:07 p.m. - 8:16 p.m.
S/S Dec.	5/6	6:07 p.m. - 9:24 p.m.
S/M Dec.	6/7	6:07 p.m. - 10:34 p.m.
M/T Dec.	7/8	6:08 p.m. - 11:46 p.m.
T/W Dec.	8/9	6:08 p.m. - 12:58 a.m.
W/T Dec.	9/10	6:08 p.m. - 2:13 a.m.
T/F Dec.	10/11	6:08 p.m. - 3:29 a.m.
F/S Dec.	11/12	6:08 p.m. - 4:48 a.m.
S/S Dec.	**12/13**	**6:08 p.m. - 5:41 a.m.**
S/M Dec.	**13/14**	**6:09 p.m. - 5:42 a.m.**
M/T Dec.	**14/15**	**6:09 p.m. - 5:42 a.m.**
T/W Dec.	**15/16**	**6:09 p.m. - 5:43 a.m.**
W/T Dec.	16/17	6:34 p.m. - 5:43 a.m.
T/F Dec.	17/18	7:43 p.m. - 5:44 a.m.
F/S Dec.	18/19	8:52 p.m. - 5:45 a.m.
S/S Dec.	19/20	9:59 p.m. - 5:45 a.m.
S/M Dec.	20/21	11:04 p.m. - 5:46 a.m.
M/T Dec.	21/22	12:06 a.m. - 5:46 a.m.
T/W Dec.	22/23	1:06 a.m. - 5:47 a.m.
W/T Dec.	23/24	2:06 a.m. - 5:47 a.m.
T/F Dec.	24/25	3:07 a.m. - 5:47 a.m.
F/S Dec.	25/26	4:08 a.m. - 5:48 a.m.
S/S Dec.	26/27	5:10 a.m. - 5:48 a.m.
S/M Dec.	27/28	none
M/T Dec.	28/29	none
T/W Dec.	29/30	none
W/T Dec.	30/31	none
T/F Dec.	31/1	none

Times listed are for Dodgeville, Wisconsin when
(1) Moon is below the horizon
(2) Sun is > 18° below the horizon
(astronomical twilight)

Time Travel

conducted by David Oesper

Continued from last month...

Hunting for Comets and Planets*

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Just as optical diffraction helps us to identify comets and measure their distances, gravitational lensing helps us to identify planets. Gravitational lensing is the focusing of light from a background object by the gravitational field of the planet. Because of the lensing effect, the signature of a planet passing in front of a distant star is not a darkening but a brightening of the light from the star. The lensing dominates the shadowing effect of the planet. The apparent diameter of the gravitational lens, the region within which substantial brightening is seen, turns out to be about ten times the diameter of the planet. For a planet as massive as the Earth at the distance of the Hyades, the diameter of the lens is 10^{-10} radians, equal to the apparent diameter of a comet in the Kuiper Belt. We can use the same stars to look for planetary lensing and for comets. But the lensing by a planet is a slow process. Since the diameter of the lens is of the order of 10^5 km, the lensing last for about an hour instead of a fraction of a second. In looking for planets, we could examine many more faint stars in a more leisurely fashion, reading out light-intensities every few minutes instead of a hundred times a second. There would be plenty of time to collect enough light from a magnitude-18 star to identify a lensing event unambiguously. The measurement is slow enough that it is not seriously affected by atmospheric turbulence.

As planetary lensing is slow, the expected event-rate is low. Even with the optimistic assumption that our Galaxy contains a thousand loose planets for every star, we expect each background star to be lensed about once in 100000 yrs. This sounds discouraging. However, the situation is not hopeless. The slow read-out of data allows us to use in the search for planets the cheap and convenient Charge Coupled Device or CCD detector instead of a multichannel photometer. With a modern CCD detector, a small telescope could monitor a thousand magnitude-18 stars in a one-degree field. Unlike the search for comets, which requires every telescope in an array to stare at the same stars, the search for planets would have each telescope looking at a different set of stars. An array of a hundred small telescopes could monitor 10^5 stars for lensing events, and could expect to see one event per year.

The search for loose planets is a highly speculative undertaking. The Galaxy is probably not swarming with planets. It would make no sense to embark on the building of an array of telescopes dedicated to the search for planetary lensing events alone. The probability of total failure is too high. But it would make sense to add a capability for planet-search to an array dedicated to the search for comets. The comets in the Kuiper Belt are known to exist and can certainly be detected. An array dedicated to comet-search will have enough success to justify its existence–and it happens that a single array can efficiently search for comets and for planets by creative use of time-sharing. Since planetary lensing events are slow, the array does not need to look at stars continuously to catch them. It is enough to look at stars for a few seconds in each minute. I envisage a combined search for comets and planets, with the detection equipment in each telescope switching on and off, using 54 s in each minute for comets and 6 s for planets. We would then have complete coverage of planetary lensing events using only 10 per cent of the time, while losing only 10 per cent of the comets.

* The text of the Milne Lecture, delivered 1991 October 24.

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To be continued next month...