to velocities, the disc values, extrapolated to the
limb, give a redshift of 655 meters per second compared
to the value of 636 meters per second predicted from
the Principle of Equivalence. Observations of the
CHROMOSPHERIC OXYGEN LINES IN EMISSION at the Sun’s
limb give a velocity difference of 627 meters per second
or 0.99 of the Einstein prediction.

Session 9: History and Education
Oral Session, 10:00–11:30 am
Henderson, Michigan League

9.01
Shang Dynasty Oracle Bone Eclipse Records and the Earth’s Rotation Rate in 1302 BC
K. D. Pang (JPL/Caltech), H. H. Chou (East Asian Lang./UCLA),
K. Yau (Durham U.), J. A. Bangert (USNO), D. A. Ahluwalia (JPL)
In 1899 Shang (1600–1100 BC) oracle bones were discovered in an
apothecary, sold as ‘dragon bones’. Among 160,000 pieces excavated from the late
Shang capital Yin (36.1N, 114.3E) is a plastron inscribed with “Diviner Ko:... day yi-mao [cyclic day 52] to [next]
dawn, fog. Three flames are the sun. Big stars [seen].” This is
undoubtedly a total solar eclipse record, as the ‘flames’ (solar
corona) and stars can be seen only during totality (Sol. Phys. 66, 187).
To decide which of 2 total solar eclipses, 6/5/1302 BC or
3/4/1250 BC, is the right one we must simultaneously solve the
problem of contemporary verified Shang lunar eclipse records, listed here in order of decreasing relative ages by writing analysis
(Takahashi, 1968):

Eclipse Day (Modulo 60) | Lunar Month | Diviner
---|---|---
31 | chia-wu | Not Stated
57 | keng-shen | Not Stated
20 | kuei-wei | Not Stated
22 | yi-yu | Not Stated
9 | jen-shen | Not Stated

Matching eclipse dates should range <60 yr, as Pin, Cheng and Ko
served King Wu Ting at the same time. Assuming that the Shang
day was either ‘Egyptian’ (dawn to dawn) or ‘Roman’ (12 am to 12
am) previous researchers could not find a set of 5 computed eclipses
that satisfy all conditions (Chang, Shang Civilization, 328).
However the Chinese day, unlike either, began at 3 am. Events that occurred
between 12 am and dawn had a 85% probability of being recorded with
the old date, and 15% with the new (Chin. Astron. S, 111).
With this new knowledge and a ΔT derived from the 1302 BC solar
eclipse, 7h 20m ± 20m, we successfully matched all 5 lunar eclipse records:
Day 31 (12/25/1322 BC), day 57 (11/24/1311 BC), day 9
(11/4/1282 BC), day 22 (9/2/1279 BC), and day 20 (2/27/1278 BC).
Our dates span only 44 yr, are consistent with the Chinese way
of recording days, and agree with relative ages from writing analysis
(with the exceptions of the youngest dates which are too close to rank
by style changes, as they are separated by <4 years). The Earth’s
rotation rate in 1302 BC was 0.047 sec faster than now. Research
supported by NASA, US Navy and Dudley Observatory.

9.02
W. W. Campbell of Lick Observatory: The Creative Scientist Who Became a Radial-Velocity Factory Manager
D. E. Osterbrock (Lick Observatory/UCSC)

W. W. Campbell was born in northern Ohio, and educated at the
University of Michigan. He majored in engineering,
but had a strong interest in mathematics. Between his
junior and senior years he read Newcomb’s "Popular Astro-
nomy" in two days, and decided to make astronomy his
career. After graduation he taught mathematics at
the University of Colorado for two years, and then returned
at Ann Arbor as an instructor in astronomy for three more
years before joining the Lick staff. There he pioneered in
observational spectroscopy with the 36-inch refractor,
first in studies of nebulae, "helium stars," and planets
(especially Mars), and then primarily in radial-velocity
determinations. After becoming director in 1901, Campbell
increasingly built the observatory research program around
this problem. Also, he led several eclipse expeditions
all over the globe. In 1923 Campbell became president of
the University of California, but retained his directorship.
When he retired in 1930, he had been director for
29 years. In this paper some of the aspects of his
career only touched upon in "Eye on the Sky" are treated
in more detail; the 1908 Flint Island eclipse expedition;
Campbell’s 1909 Mount Whitney Mars expedition; his activ-
ties in the International Union for Cooperation in Solar
Research from its first conference in 1904 to his term as
president of its successor, the International Astronomical
Union, 1922-25; his relationship with the University of
Michigan; and his years as president of the National
Academy of Sciences and as a member of the Science Advisory
Board established by President Franklin D. Roosevelt.

10.01
Starburst Galaxies from z = 0.000 to z = ?
M. J. Rieke (U. Arizona)
The earliest observations of galaxies at infrared wavelengths revealed
that a significant fraction of galaxies emit at levels far above that
expected from an old, quiescent stellar population. As infrared observing
techniques grew more sophisticated, the infrared excesses of normal
galaxies were identified as the hallmark of star formation in their nuclei.
This star formation or "starbursting" presents an opportunity to study
star formation in a situation quite different from the less violent star
formation studied in the solar neighborhood. Because this nuclear star
formation may be similar to star formation early in a galaxy's history, an
understanding of nearby starburst galaxies may reveal details and
mechanisms that cannot be studied in more distant galaxies.

The center of the Milky Way itself has formed stars in the recent past.
By using new infrared imaging techniques and infrared spectroscopy,
the Galactic Center stellar population can be thoroughly characterized.
Radial velocities have been measured for the first time, and the existence of
a massive black hole and so that how the star formation
is sustained. The relationship of the 2 pc molecular ring to the stel-
lar population can be investigated to learn whether the ring is the source
of material for the next star formation.

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