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 CHROMOSPERIC 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 100,000 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...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 (Sll. Figs. 85, 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 (Takashima, 1988).

Eclipse Day (Modulo 60) Lunar Month Diviner
31 chia-wu Not Stated Pin
37 keng-shen 13th (=Nov., Dec. or Jan.) Cheng
29 kuei-wei Not Stated Cheng
22 yi-yu 8th (=Jul., Aug. or Sept.) Cheng
9 jen-shen Not Stated N/S

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 65% probability of being recorded with the old date, and 15% with the new (Chin. Astron. 5, 111). With this new knowledge and a ΔT derived from the 1302 BC solar eclipse, 7h 20m ± 20m, we successfully match 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 Astronomy” 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 to 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 Lick 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 activities 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.

9.03
The Generation of New Images on Optical Laser Disks for Astronomy Teaching in Planetariums and Classrooms
W.A. Gutsch (Am. Mus.-Hayden Pl.)

At the American Museum-Hayden Planetarium and elsewhere a new generation of optical laser disks are being created which depict a wide variety of astronomical phenomena and related materials. The resulting images can be seen in classroom settings but with minor adjustment of projector brightness and contrast controls can also produceformatless effects for planetarium domes. Examples of recent experiments will be shown and discussed as well as interesting applications for use in interactive and audience paced programs for children and adults. This work was supported in part by grants from the S.H. and Helen R. Scheuer Family Foundation and the Howard Philips Foundation.

Session 10: Invited Talk
Oral Session, 11:40 am–12:30 pm
Auditorium 3, Modern Languages Building

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 result 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, indicating the existence of a massive black hole and for clues as to how the star formation is instigated. The relationship of the 2 pc molecular ring to the stellar population can be investigated to learn whether the ring is the source of material for the recent star formation.

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