1100 in one step from X-band. If successful, this precedure will allow a direct comparison of a 10.7-THz (28 micron) H_2O laser frequency with an X-band frequency standard.

Their pioneering work in high-order single-step frequency multiplication should be regarded as a significant advance towards very versatile methods of infrared and visible radiation frequency synthesis that will be highly precise as well as being relatively simple, inexpensive and reliable. These desirable features are expected to be attainable partly because it is possible to compare two frequencies directly, although they differ by much more than a factor of 12. The eventual impact on technology and science may be considerable.[3,4]

References

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Comparing frequencies

In the interesting news item "Absolute laser frequency measurements" (April, 1972, page 17), which described the measurement of the 88-THz frequency of cesium, a statement was made that "A chain of experiments is needed because two frequencies differing by more than a factor of 12 cannot be compared directly." Although the article otherwise was very well written, this statement is incorrect and misleading.

On 3 September 1970, D. G. McDonald, A. S. Risley, J. D. Cupp, and K. M. Evenson at the National Bureau of Standards in Boulder directly compared the 0.89-THz frequency (337-micron wavelength) of an HCN laser with an X-band frequency. This was a factor of 100 in one step.[1] On 12 August 1971 the same group directly compared the 3.82-THz frequency (78 micron) of an H_2O laser with an X-band frequency. This was a factor of 401 in one step.[2] They used a Josephson junction as the nonlinear element. Although the multiplication factor was far greater than 12, the signal-to-noise ratios obtained in these experiments were excellent, and McDonald and coworkers presently are setting up an experiment to obtain a factor of about

KENNETH EVENSON REPLIES: Donald Halford's comments are correct. The sentence in question could be better expressed: A chain of lasers is needed when one uses the room temperature metal-metal diode because the signal-to-noise ratio decreases with increasing harmonic numbers, thus limiting the maximum useful harmonic number. The twelfth harmonic was the maximum one used in the experiments described in the April issue as well as those revised ones reported in Halford's reference 1, which resulted in the 100-fold improvement in the accuracy of the speed of light. However, signals with higher harmonic numbers from metal-metal diodes might be obtainable with longer averaging times. We presently are setting up an experiment to obtain a factor of 33 in one step from a laser with a metal-metal diode. Much higher laser harmonics might be obtainable with the Josephson junction.

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