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A Large Prime Gap

By Sol Weintraub

Abstract. A prime gap of 654 (653 consecutive composites) is found near 1.1×10^{16}.

A prime gap of 654 was found following the prime 11 000 001 446 613 353. The highest gap previously published, 652, follows the prime 2 614 941 710 559, (Brent [1]). Only smaller gaps occur below that prime. Theoretically, a gap of magnitude at least n can be found following the integer $n!+1$ but this is of little practical value. For example, $654! \sim 1.47 \times 10^{1559}$.

Only four other gaps exceeding 500 were found in the interval between $N = 1.1 \times 10^{16}$ and $N + 1.5 \times 10^9$. According to Shanks' [2] conjecture, a gap of approximate size 1364 should exist somewhere below this N; but gaps of that size are very rare.

The five gaps exceeding 500 in this interval are

GAP	FOLLOWING
546	11 000 000 002 331 551
510	11 000 000 370 769 591
528	11 000 000 410 410 853
504	11 000 000 593 773 869
654	11 000 001 446 613 353

Listed below are the maximum gaps in each interval of 100 million, beginning at $N = 1.1 \times 10^{16}$ and ending at $N + 1.5 \times 10^9$:

546, 468, 484, 510, 528, 504, 494, 484, 460, 486, 486, 496, 496, 476, 654

e.g., the first number, 546, is the maximum gap between $N = 1.1 \times 10^{16}$ and $N + 10^8$.

For purposes of comparison, the maximum gaps (per 100 million) beginning at 1.1×10^{13} are:

428, 396, 388, 370, 438, 356, 492, 380, 394, 390, 440, 396, 418, 384, 392.

Again, this shows that the occurrence of large prime gaps is exceedingly rare.

Department of Mathematics
Queens College, CUNY
Flushing, New York 11367

→ R. BRENT, "The first occurrence of large gaps between successive primes," *Math. Comp.*, v. 27, 1973, pp. 959–963.

2. D. SHANKS, "On maximal gaps between successive primes," *Math. Comp.*, v. 18, 1964, pp. 646–651.

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