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A Cesàro Average of Goldbach numbers

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Let Λ be the von Mangoldt function and (r_G(n) = \sum_{m_1 + m_2 = n} \Lambda(m_1) \Lambda(m_2)) be the counting function for the Goldbach numbers. Let $N \geq 2$ be an integer. We prove that &\sum_{n \le N} r_G(n) \frac{(1 - n/N)^k}{\Gamma(k + 1)} = \frac{N^{2}}{\Gamma(k + 3)} - 2 \sum_{\rho} \frac{\Gamma(\rho)}{\Gamma(\rho + k + 2)} N^{\rho+1} &\qquad+ \sum_{\rho_1} \sum_{\rho_2} \frac{\Gamma(\rho_1) \Gamma(\rho_2)}{\Gamma(\rho_1 + \rho_2 + k + 1)} N^{\rho_1 + \rho_2} + \Odip{k}{N^{1/2}}, for $k > 1$, where ρ, with or without subscripts, runs over the non-trivial zeros of the Riemann zeta-function $\zeta(s)$.

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