

# Remarks on Birch and Swinnerton-Dyer Conjecture

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January 26, 2020

## Abstract

These short remarks show derivation of Birch and Swinnerton-Dyer conjecture. As a consequence new one resulting constant free equality of Birch and Swinnerton-Dyer conjecture proposed

We know, that Euler product in general equals to the infinitesimal sum. Therefore, for big enough  $N$  finite Euler product can be approximated as finite sum in the same way as follow:

$$\prod_{p < N} \frac{N_p}{p} = \prod_{p < N} P(p, 1) = \prod_{p < N} \frac{1}{1 - \frac{1}{p} \frac{pN_p - p^2}{N_p}} \approx \sum_{n < N} \frac{1}{n} \frac{nN_n - n^2}{N_n} \quad (1)$$

where  $N_p$  is the number of points modulo  $p$  for a large number of primes  $p$  on elliptic curves whose rank  $r$  was known and  $N_n$  is the number of points modulo  $n$  for a large number of positive integers  $n$  on elliptic curves for the same rank  $r$ . On the other hand, the finite sum can be approximated as integral by using Euler–Maclaurin formula [1]:

$$\sum_{n < N} \frac{1}{n} \frac{nN_n - n^2}{N_n} \approx \int_{x=1}^N \frac{N_x - x}{N_x} dx \quad (2)$$

Let's deside, that  $N_x = x / \left(1 - C \frac{r(\log x)^{r-1}}{x}\right)$  dependance is valid<sup>1</sup>. After inserting this expression into the integral we obtain:

$$\int_{x=1}^N \frac{N_x - x}{N_x} dx = C \int_{x=1}^N \frac{r(\log x)^{r-1}}{x} dx = C(\log N)^r \quad (3)$$

Finally, expanding  $N_x$  near 0 and taking just first term, we can write for big enough  $N$ :

$$\prod_{p < N} \frac{N_p}{p} \approx \frac{N_N \log N}{r}$$

## References

- [1] Abramowitz, Milton; Stegun, Irene A., eds. (1972). *Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables*. New York: Dover Publications. ISBN 978-0-486-61272-0. tenth printing., pp. 16, 806, 886

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<sup>1</sup>It can be proved by numeric experiment