LETTERS TO THE EDITOR

ON $\tau(n)$ MODULO 49

A CAREFUL study of my "Table of Values of $\tau(n)$" for values of n up to 400, has led me to the

Conjecture: If p be a prime of the form $7q + r$, where $r = 3, 5$ or 6

then

$$\tau(p)/7 \equiv r - 1 - [3/r] - 2q \pmod 7,$$

where $\tau(n)$ is Ramanujan's function and $[x]$ denotes as usual the greatest integer in x. It may be noted that

Lehmer's Conjecture: If p_1 and p_2 be primes congruent modulo 49 and $\left(\frac{p_1}{7}\right) = -1$,

then $\tau(p_1^{\alpha}) \equiv \tau(p_2^{\alpha}) \pmod{49}$, $\alpha \geqslant 1$, would follow readily from my conjecture and the well-known result

$$\tau(p^m) = \tau(p)\,\tau(p^{m-1}) - p^{11}\,\tau(p^{m-2}),\ m \geqslant 2.$$

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January 5, 1949.

Gupta, H., "Table of Values of $\tau(n)$," *Proc. Nat. Inst. Sci., India*, 1947, **13**, 201-6.

Lehmer's Conjecture was conveyed to me by R. P. Bambah in a recent letter.

HARMONIC ANALYSIS AND EXPERIMENTAL DATA

THE chief characteristics of yields of most of the perennial and tree crops in successive years are the presence of cyclic changes and trends, great variability in the yields of plants in the same year and the correlation between the yields of the plants in successive years. Such trends, cyclic changes, variability and correlation in the data are common in experimental data of some other branches of studies such as economics, biology, etc.

The characteristics mentioned above offer some difficulties in the study and interpretations of experimental data and in obtaining conclusive results from experiments. Inconsistent results are at times obtained by applying the usual methods of the analysis of variance for the data of individual years or experiments. Orthogonal polynomials have been frequently used to represent trends in the experimental data. But they are unlikely to be of much use in representing the nature of trends mentioned earlier.

One of the methods, which appears to be satisfactory, would be to represent the data by a multiple regression equation of the type $y_t = bt + A \cos \frac{2\pi t}{T} + B \sin \frac{2\pi t}{T} +$ constant,

where y_t = Yield for year t

b = linear regression coefficient

A and B = Fourier constants of the harmonic. Trends of higher order like parabolic etc., may also be represented by adding terms like $Ct^2 + dt^3$, etc., to the above equation.

This is illustrated by taking yield data of a perennial crop for 9 years, which exhibited certain definite trends, cyclic changes and random variations. Application of orthogonal polynomials gave the following analysis of variance.

Source of variation	d.f.	M.S.
Deviation from mean ..	8	2711
Linear regression ..	1	8874
Quadratic ..	1	523
Cubic ..	1	399
Quartic ..	1	622
Quintic ..	1	4608
Deviations ..	3	2221

These have removed a certain portion of the variation in the series, periodogram analysis with trial periods of 2, 3, 4 and 5 years showed that the energy of the third harmonic is maximum. This harmonic is

$$7 \cdot 3 \cos \frac{2\pi t}{3} - 46 \cdot 13 \sin \frac{2\pi t}{3}.$$

Tests of significance as developed by Schuster modified by Walker and finally by Fisher can be applied. The extent to which the harmonic will represent the data may be examined by finding the reduction in the variance of the series after removal of the cyclic changes. Nearly 50% of the total variation can be explained by the harmonic.

The variation in yield can be more completely represented by the multiple regression equation

$$y = 10 \cdot 68 - 3 \cdot 37 \cos \frac{2\pi t}{3} - 39 \cdot 96 \sin \frac{2\pi t}{3}$$

assuming that the cyclic changes are represented by a 3-year cycle. The analysis of variance would be

Source of variation	d.f.	M.S.
Regression ..	3	5326
Deviation ..	5	1140

The level of significance is near 5%. Thus, it would be possible in any experiment to examine and see if the regressions have been influenced by the treatments and if they differ from plot to plot. It is probable in some cases, the amplitude varies with time suggesting existence of damped harmonics.

More details on this will be appearing elsewhere.

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March 6, 1949.

ON THE INVESTIGATION OF π AND μ MESONS

EXPERIMENTS performed in Rome by Dr. Conversi, Pancini and Piccioni[1] on the interaction of mesons with matter have revealed the interesting fact that positive mesons decay in iron while the negative ones do not and are presumably captured by the nuclei. On the other hand, all the mesons—both positive and negative, decay in carbon; few could be captured by the nuclei. These results were later confirmed by Valley and Rossi (M.I.T.)[2] by much more elaborate apparatus incorporating both Wilson cloud-chamber and counters with delayed circuit.

This difficulty of weak interaction of the mesons with nuclei may be resolved if we assume that there are fundamentally two types of mesons with different masses.[3] The lighter mesons which we observe at sea level are in fact produced as a result of the spontaneous decay of the heavier mesons that are formed at greater heights by proton primaries. This postulate appears to be confirmed by Powell and Ochhialini in Bristol[4] by the photographic method. These workers call them μ and π mesons respectively. μ meson is the light meson of non-interacting type and π meson is the heavier interacting type. This hypothesis (of interacting and non-interacting types) refers to π^- and μ^- mesons, π^+ and μ^+ meeting always the same fate, *i.e.*, suffering β decay.

The most probable height of formation of mesons was shown by Euler and Heisenberg[5] while explaining absorption anomalies to be 16 km. above sea level. This has been confirmed by A. Duperier[6] from the consideration of temperature effect.