

FLORENTIN SMARANDACHE
**Contributii la studiul unor functii
si conjecturi in Teoria Numerelor**

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CONTRIBUȚII LA STUDIUL UNOR FUNCȚII ȘI CONJECTURI ÎN TEORIA NUMERELOR

Teoria Numerelor reprezintă pentru mine o pasiune. Rezultatele expuse mai departe constituie rodul câtorva ani buni de cercetări și căutări.

Actualitatea temei este evidentă, din moment ce la Universitatea din Craiova, Conf. dr. C. Dumitrescu & Conf. dr. V. Seleacu organizează <Prima Conferința Internațională dedicată Noțiunilor de tip 'Smarandache' în Teoria Numerelor>, și anume: funcții (η și extinderi ale sale, L , funcții prime), secvențe, operații speciale, criterii de divizibilitate, teoreme, etc. de tip 'Smarandache', în perioada 21-24 August 1997 [vezi și anunțul din "Notices of the American Mathematical Society", University of Providence, RI, SUA, Vol. 42, No. 11, rubrica "Mathematics Calendar", p. 1366, Noiembrie 1995]. Conferința se va desfășura sub egida UNESCO [240] [cf. Mircea Ichim, director, și Lucreția Băluță, secretară, Filiala UNESCO din București].

În felul acesta se deschid noi drumuri în Teoria Numerelor, formând un domeniu aparte, care a trezit interesul diversilor specialiști.

Un grup de cercetare privind aceste noțiuni, în special concentrat asupra Funcției Smarandache, s-a format la Universitatea din Craiova, România, Catedra de Matematică, condus de către Prof. dr. A.Dincă (decan), Prof. dr. V.Boju, Conf. dr. V.Seleacu, Conf. dr. C.Dumitrescu, Conf. dr. I.Bălăcenoiu, Conf. dr. Șt.Zanfir, Conf. dr. N.Rădescu, Lect. E.Rădescu, Lect. dr. I.Cojocaru, Lect. dr. Paul Popescu, Asist. drd. Marcela Popescu, Asist. N.Virlan, Asist. drd. Carmen Roșoreanu, prof. S.Cojocaru, prof. L.Tițulescu, prof. E.Burton, prof. Panait Popescu, cercet. șt. M.Andrei, student Tomiță Tiberiu Florin, și alte cadre didactice împreună cu studenți.

Membrii acestui grup se întâlnesc o dată pe săptămână, în timpul anului școlar, și expun ultimele cercetări asupra funcției η , precum și încercări de generalizare.

În afara grupului de cercetare de la Craiova, destui matematicieni și informaticieni străini s-au ocupat de studiul funcției η , cei mai activi fiind: Henry Ibstedt (Suedia), Pål Grönås (Norvegia), Jim Duncan, John C.MacCarthy, John R. Sutton (Anglia), Ken Tauscher (Australia), Th. Martin (SUA), Pedro Melendez (Brazilia), M.Costewitz (Franța), J.Rodriguez (Mexic), etc. [Pentru o imagine mai detaliată, vezi cele 240 de "Referințe" de la sfârșit.]

Despre însemnătatea "Funcției Smarandache", cum a fost botezată în revista londoneză

<Personal Computer World>, Iulie 1992, p. 420; și-a dat pentru prima dată seamă scientistul englez Mike Mudge, editor al rubricii <Numbers Count> [10]. Iar valorile funcției, $\eta = 1, 2, 3, 4, 5, 3, 7, 4, 6, 5, 11, 4, 13, \dots$ au fost etalate de N. J. A. Sloane & Simon Plouffe în <Encyclopedia of Integer Sequences>, Academic Press, [M0453], 1995, și denumite "Numerele Smarandache" [140].

Articolele, notele, problemele (rezolvate sau deschise), conjecturile referitoare la această nouă funcție în teoria numerelor sunt colectate într-o revistă specială numită "Smarandache Function Journal", publicată anual ori bianual, de Dr. R. Muller, Number Theory Publishing Co., Glendale, Arizona, SUA.

Mai mult, Ch. Ashbacher (SUA) i-a dedicat însăși o monografie: "An introduction to the Smarandache function", Erhus Univ. Press, Vail, 1995 [194], iar Kenichiro Kashihara (Japonia) are în pregătire o altă carte despre η [235].

De asemenea, multe reviste și chiar enciclopedii și-au deschis paginile inserării de lucrări ce tratează, recenzează, sau citează funcția η și valorile ei [vezi "Personal Computer World" (Londra), "Humanistic Mathematics Network Journal" (Harvey Mudd College, Claremont, CA, SUA), "Libertas Mathematica" (Texas State University), "Octogon" (Brașov, România), "Encyclopedia of Integer Sequences" N. J. A. Sloane & Simon Plouffe (Academic Press; San Diego, New York, Boston, London, Sydney, Tokyo, Toronto; 1995), "Journal of Recreational Mathematics" (SUA), "Foaie Matematică" (Chișinău, Moldova), "The Mathematical Spectrum" (University of Sheffield, Anglia), "Elemente der Mathematik" Elveția, "Zentralblatt für Mathematik" (Berlin, Germania), "The Mathematical Reviews" (Ann Arbor, SUA), "The Fibonacci Quarterly" (SUA), etc.].

Iar la conferințe naționale și internaționale organizate, de exemplu la New Mexico State University of San Antonio (Texas), University of Arizona (Tucson), University of San Antonio (Texas), State University of New York at Farmingdale, University of Victoria (Canada), Congres International < Henry Poincaré > (Université de Nancy, Franța), <26th Annual Iranian Mathematics Conference> (Kerman, Iran), <The Second Asian Mathematics Conference> (Nakhon Ratchasima, Tilanda), <Programul manifestărilor organizate cu prilejul împlinirii a 100 ani de la apariția primului număr al revistei 'Gazeta Matematică' 1895-1995> (Alba-Iulia, România), etc. s-au prezentat articole științifice despre η în perioada 1991-5.

Arhivele care stochează cercetările asupra funcției η (cărți, reviste, broșuri, manuscrise

publicate ori inedite, articole note, comentarii, scrisori, - obișnuite ori electronice - de la diverși matematicieni și editori, probleme, aplicații, programe de conferințe și simpozioane, etc.), cât și asupra altor noțiuni din teză, se gesesc la:

a) Arizona State University, Hayden Library, Colecția Specială (online) "The Florentine Smarandache papers", Tempe, AZ 85287, USA; phone:(602) 965-6515, e-mail:

ICCLM@ASUACAD.BITNET, responsabile:Carol Moore & Marilyn Wurzburger;

b) Arheves of American Mathematics, Center for American History SRH 2.109, University of Texas, Colecția Specială "The Florentine Smarandache papers", Austin, TX 78713, USA; phone: (512) 495-4129, fax: (512) 495-4542, director Don Carleton;

c) Biblioteca University din Craiova, Str. Al. I. Cuza, Nr. 13, Secția de Informare și Documentare "Florentine Smarandache" din cadrul Seminarului Matematic <Gh. Țițeica>, director O. Lohon, bibliotecară Maria Buz, fax: (051) 411688, România;

d) Arhivele Statului, Filiala Vâlcea, Fondul Special "Florentin Smarandache", responsabil: Ion Soare, Str. General Praporgescu, Nr.32B, Rm. Vâlcea, Jud. Vâlcea, România; care sunt puse la dispoziția publicului spre consultare.

Se definește, așadar, o nouă funcție:

$$n: \mathbb{Z}^* \rightarrow \mathbb{N},$$

$\eta(n)$ este cel mai mic întreg m astfel încât $m!$ este divizibil cu n .

Această funcție este importantă deoarece caracterizează numerele prime - prin următoarea proprietate fundamentală:

Fie p un număr întreg > 4 , atunci p este prim dacă și numai dacă $\eta(p) = p$.

Deci, punctele fixe ale acestei funcții sunt numere prime (la care se adaugă și 4). Datorită acestei proprietăți, funcția η se folosește ca o sită pentru cernerea numerelor prime.

Studierea și descoperirea unor relații despre funcția η duce implicit la aprofundarea cunoștințelor despre numerele prime, o preocupare în prezent fiind distribuția lor. [F.Burton încearcă generalizarea funcției η în corpul numerelor complexe [169].]

Totodată, funcția η intră în conexiune și cu foarte cunoscuta Funcție $\Pi(x)$, care reprezintă numărul de numere prime mai mici decât sau egale cu x , prin următoarea formulă:

$$\text{Pentru } x \geq 4, \Pi(x) = \sum_{k=2}^x [\eta(k)/k] - 1,$$

unde $[b]$ înseamnă partea întreagă a lui b .

[vezi L.Seagull [189]].

Alte proprietăți:

Dacă $(a, b) = 1$, atunci $\eta(ab) = \max\{\eta(a), \eta(b)\}$.

Pentru orice numere pozitive nenule, $\eta(ab) \leq \eta(a) + \eta(b)$.

η este o funcție general crescătoare, adică:

$$\forall a \in \mathbb{N} \exists b \in \mathbb{N}, b = b(a), \forall c \in \mathbb{N}, c > b, \eta(c) > a.$$

Funcția η face obiectul multor probleme deschise, care au trezit interesul matematicienilor.

De exemplu:

a) Ecuația $\eta(n) = \eta(n+1)$ nu are nici o soluție.

Nu a fost încă demonstrată, deși I.Prodănescu [29, 92] crezuse inițial că i-a găsit soluția. L.Țuțescu [30] i-a dat o extindere acestei conjecturi.

b) A.Mullin [239], inspirat de problema anterioară, conjecturează că ecuația $\eta(n) = \eta(n+2)$ are doar un număr finit de soluții.

c) T.Yau [69] a propus determinarea tuturor valorilor pentru care funcția η păstrează relația de recurență a lui Fibonacci, adică:

$$\eta(n) + \eta(n+1) = \eta(n+2),$$

neștiindu-se dacă acestea sunt în număr finit sau infinit. El însuși aflând pe $n = 9, 119$. Ch.Ashbacher [182, 207] a investigat relația de mai sus cu un program pe calculator până la $n = 1000000$, descoperind valori adiționale pentru $n = 4900, 26243, 32110, 64008, 368138, 415662$, dar nedemonstrând cazul general. H.Ibstedt [224] presupune că există o infinitate de astfel de triplete.

d) Renumitul academician, P.Erdős [147], de la Academia Ungară de Științe, solicită cititorilor revistei engleze <Mathematical Spectrum>, în care publică o scrisoare, să găsească o formulă asimptotică pentru:

$$\sum_{n < x} \eta(n)^2, \\ \eta(n) > P(n)$$

unde $P(n)$ reprezintă cel mai mare factor prim al lui n .

Fiecare perioadă de timp are problemele ei deschise, cărora de obicei li se dă de cap mai târziu, odată cu progresul științei. Și, totuși, numărul noilor probleme nerezolvate, care apar datorită cercetărilor firește, crește exponențial, în comparație cu numărul vechilor probleme nerezolvate ce sunt în prezent soluționate. Oare existența problemelor deschise constituie o criză matematică ori, dimpotrivă, absența lor ar însemna mai degrabă o stagnare intelectuală?

"Funcția Smarandache" este pusă în combinații și relații cu alte funcții ori noțiuni din teoria numerelor și analiză, precum: secvențe- A , numărul de divizori, diferența dintre două numere prime consecutive, serii Dirichlet, funcții generatoare, funcția logaritmică, ordin normal, condiții Lipschitz, funcții multiplicative ori aditive, cel mai mare factor, distribuție uniformă, rădăcini necongruente, cardinal, triunghiul lui Pascal, secvență s -aditivă, suma părților alicuante, suma puterilor de ordin k ale părților alicuante, suma părților alicuante unitare, mediile aritmetică și geometrică, șiruri recurente, ecuații și inecuații diofantice, numărul de numere prime, numărul de numere prime congruente cu a modulo b , suma divizorilor, suma puterilor de ordin k ale divizorilor, suma divizorilor unitari, funcția φ a lui Euler, funcțiile gamma și beta, numărul de factori primi (cu repetiție), numărul factorilor primi distincți, partea întreagă, aproximații asimptotice, câmpuri algebrice, funcția Mobius, funcțiile Cebîșev Θ și Ψ , etc.

Iar "Numerele Smarandache" sunt asociate și întrepătrunse respectiv cu: numerele abundente, aproape perfecte, amicale, amicale mărite, numerele Bell, Bernoulli, Catalan, Carmichael, deficiente, Euler, Fermat, Fibonacci, Genocchi, numerele armonice, h -hiperperfecte, Kurepa, Mersenne, m -perfecte, numerele norocoase, k -îndoite perfecte, perfecte, poligonale, piramidale, poliedrale, primitive abundente, primitive pseudoperfecte, pseudoperfecte, pseudoprime, pitagoreice, reziduri pătratice, cvasiperfecte, Stirling de ordinul I și II, superperfecte, intangibile, numerele sinistre, numerele Ulam, etc.

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presented as:

"SMARANDACHE NUMBERS": $S(n)$, for $n = 1, 2, 3, \dots$, [MO543], (the values of the Smarandache Function),

and

"SMARANDACHE QUOTIENTS": for each integer $n > 0$, find the smallest k such that nk is a factorial, i.e. $S(n)/n$, for $n = 1, 2, 3, \dots$;

and in the newest electronic version of the encyclopedia there are some other notions:

"SMARANDACHE DOUBLE FACTORIALS", "SMARANDACHE SQUARE BASE", "SMARANDACHE CUBIC BASE", "SMARANDACHE PRIME BASE",

"SMARANDACHE SYMMETRIC SEQUENCE", "SMARANDACHE CONSECUTIVE SEQUENCE", "SMARANDACHE DESTRUCTIVE SEQUENCE", "SMARANDACHE MIRROR SEQUENCE", "SMARANDACHE PERMUTATION SEQUENCE", "SMARANDACHE REVERSE SEQUENCE", "SMARANDACHE CONSECUTIVE SIEVE";

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