Contributii la studiul unor functii si conjecturi in Teoria Numerelor

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CONTRIBUŢII LA STUDIUL UNOR FUNCŢII ŞI CONJECTURI ÎN TEORIA NUMERELOR

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

Actualitatea temei aste evidentă, din moment ce la Universitatea din Craiova, Conf. dr. C. Dumitrescu & Conf. dr. V. Seleacu organizează <Prima Conferinţa Internaţională dedicată Noţiunilor de tip 'Smarandache' în Teoria Numerelor>, şi anume: funcţii (η şi extinderi ale sale, L, funcţii prime), secvenţe, operaţii speciale, criterii de divizibilitate, teoreme, etc. de tip 'Smarandache', în perioada 21-24 August 1997 [vezi şi anunţul din "Notices of the American Mathematical Societaty", University of Providence, RI, SUA, Vol. 42, No. 11, rubrica "Mathematics Calendar", p. 1366, Noiembrie 1995]. Conferinţa se va desfăfura sub egida UNESCO [240] [cf. Mircea Ichim, director, şi Lucreţia Băluţă, secretară, Filiala UNESCO din Bucureşti].

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

Un grup de cercetare privind aceste noţiuni, în special concentrat asupra Funcţiei 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. Şt.Zanfir, Conf. dr. N.Rădescu, Lect. E.Rădescu, Lect. dr. I.Cojocaru, Lect. dr. Paul Popescu, Asist. drd. Marcela Popescu, Asist. N.Vîrlan, Asist. drd. Carmen Rocşoreanu, prof. S.Cojocaru, prof. L.Tiţulescu, prof. E.Burton, prof. Panait Popescu, cercet. şt. M.Andrei, student Tomiţă Tiberiu Florin, şi alte cadre didactice împreună cu studenţi.

Membrii acestui grup se întâlnesc o dată pe săptămână, în timpul anului şcolar, şi expun ultimele cercetări asupra funcţiei η, precum şi încercări de generalizare.

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

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

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

Articolele, notele, problemele (rezolvate sau deschise), conjecturile referitoare la această nouă funcţie 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 însăşi 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 şi chiar enciclopedii şi-au deschis paginile inserării de lucrări ce tratează, recenzează, sau citează funcţia η şi valorile ei [vezi "Personal Computer World" (Londra), "Humanistic Mathematics Network Journal" (Harvey Mudd College, Claremont, CA, Sua), "Libertas Mathematica" (Texas State University), "Octogon" (Braşov, 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" (Chişinău, Mildova), "The Mathematical Spectrum" (University of Sheffield, Anglia), "Elemente der Mathematik" Elveţia, "Zentralblatt für Matematik" (Berlin, Germania), "The Mathematical Reviews" (Ann Arbor, SUA), "The Fibonacci Quarterly" (SUA), etc.].

Iar la conferinţe naţionale şi internaţionale 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), Congrès International < Henry Poincaré > (Université de Nancy, Franţa), <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 apari'ia primului număr al revistei 'Gazeta Matematică' 1895-1995> (Alba-Iulia, România), etc. s-au prezentat articole ştiinţifice despre η în perioada 1991-5.

Arhivele care stochează cercetările asupra funcţiei η (cărţi, revicte, broşuri, manuscrise

publicate ori inedite, articole note, comentarii, scrisori, - obişnuite ori electronice - de la diverşi matematicieni şi editori, probleme, aplicaţii, programe de conferinţe şi simpozioane, etc.), cât şi asupra altor noţiuni din teză, se gesesc la:

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

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

b) Archeves of American Mathematics, Center for American History SRH 2.109, University of Texas, Colecţia 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, Secţia de Informare şi Documentare "Florentine Smarandache" din cadrul Seminarului Matematic <Gh. Ţiţeica>, director O. Lohon, bibliothecară Maria Buz, fax: (051) 411688, România;

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

Se defineşte, aşadar, o nouă funcţie:

$$\eta : Z^* \longrightarrow N,$$

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

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

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

Deci, punctele fixe ale acestei funcţii sunt numere prime (la care se adaugă şi 4). Datorită acestei proprietăţi, funcţia η se foloseşte ca o sită pentru cernarea numerelor prime.

Studierea şi descoperirea unor relaţii despre funcţia η duce implicit la aprofundarea cunoştinţelor despre numerele prime, o preocupare în prezent fiind distribuirea lor. [F.Burton încearcă generalizarea funcţiei η în corpul numerelor complexe [169].]

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

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

unde $\lfloor b \rfloor$ înseamnă partea întreagă a lui b.

[vezi L.Seagull [189]].

Alte proprietăţi:

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 funcţie general crescătoare, adică:*

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

Funcţia η face obiectul multor probleme deschise, care au ttrezit interesul matematicienilor.

De exemplu:

a) *Ecuaţia* $\eta(n) = \eta(n+1)$ *nu are nici o soluţie.*

Nu a fost încă demonstrată, deşi I.Prodănescu [29, 92] crezuse iniţial că i-a găsit soluţia. L.Ţuţescu [30] i-a dat o extindere acestei conjecturi.

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

c) T.Yau [63] a propus determinarea tuturor valorilor pentru care funcţia η *păstrează relaţia de recurenţă a lui Fibonacci, adică:*

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

neştiindu-se dacă acestea sunt în număr finit sau infinit. El însuşi aflând pe $n = 9,119$. Ch.Ashbacher [182, 207] a investigat relaţia de mai sus cu un program pe calculator până la $n =$ $= 1000000$, descoperind valori adiţionale 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 Ştiinţe, solicită cititorilor revistei engeleze <Mathematical Spectrum>, în care publică o scrisoare, să găsească o formulă asimptotică pentru:

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

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 ştiinţei. Şi, totuşi, numărul noilor probleme nerezolvate, care apar datorită cercetărilor fireşte, creşte exponenţial, în comparaţie cu numărul vechilor probleme nerezolvate ce sunt în prezent soluţionate. Oare existenţa problemelor deschise constituie o criză matematică ori, dimpotrivă, absenţa lor ar însemna mai degrabă o stagnare intelectuală?

"Funcţia Smarandache" este pusă în combinaţii şi relaţii cu alte funcţii ori noţiuni din teoria numerelor şi analiză, precum: secvenţe-A, numărul de divizori, diferenţa dintre două numere prime consecutive, serii Dirichlet, funcţii generatoare, funcţia logaritm, ordin normal, condiţii Lipschitz, funcţii multiplicative ori aditive, cel mai mare factor, distribuţie uniformă, rădăcini necongruente, cardinal, triunghiul lui Pascal, secvenţă s-aditivă, suma părţilor alicuante, suma puterilor de ordin k ale părţilor alicuante, suma părţilor alicuante unitare, mediile aritmetică şi geometrică, şiruri recurente, ecuaţii şi inecuaţii 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, funcţia φ a lui Euler, funcţiile gamma şi beta, numărul de factori primi (cu repetiţie),numărul factorilor primi distincţi, partea întreagă, aproximaţii asimptoptice, câmpuri algebrice, funcţia Mobius, funcţiile Cebîşev Θ şi Ψ, etc.

Iar "Numerele Smarandache" sunt asociate şi 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 pseodoperfecte, pseudoperfecte, pseudoprime, pitagoreice, reziduri pătratice, cvasiperfecte, Stirling de ordinul I şi II, superperfecte, intangibile, numerele sinistre, numerele Ulam, etc.

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presented as:

"SMARANDACHE NUMBERS": $S(n)$, for $n = 1, 2, 3, \ldots$, [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 $n = 1, 2, 3 \ldots$;

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 DESCONSTRUCTIVE SEQUENCE", "SMARANDACHE MIRROR SEQUENCE","SMARANDACHE PERMUTATION SEQUENCE", "SMARANDACHE REVERSE SEQUENCE", "SMARANDACHE CONSECUTIVE SIEVE";

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