Resumo do Curriculum Vitae
do Prof Newton C. A. da Costa
(Universidade de São Paulo)

1. Dados Pessoais:

Nome: Newton Carneiro Affonso da Costa
Data de Nascimento: 16 de Setembro de 1929
Data de ingresso na carreira docente: março de 1950
Posição atual e regime de trabalho: Prof. Titular RDIDP (aposentado)

2. Cursos de Graduação

2.1 Engenharia Civil, UFPR, 1952
2.2 Bacharel em Matemática, UFPR, 1956
2.3 Licenciado em Matemática, UFPR, 1957

3. Pós Graduação

3.1 Doutor em Matemática, UFPR, 1960
3.2 Docente Livre de Análise Matemática e Análise Superior, UFPR, 1961
3.3 Catedrático de Análise Matemática e Análise Superior, UFPR, 1964
3.4 Professor Titular, IME – USP, 1975
3.5 Professor titular (Lógica), FFLCH – USP, 1991

4. Ensino

4.1 No Brasil: Professor e/ou conferencista em diversas instituições, tais como a Universidade Estadual de Campinas, o Instituto Tecnológico da Aeronáutica e a Universidade Federal do Rio de Janeiro.

4.2 No Exterior: Professor, professor visitante, conferencista e/ou pesquisador de várias instituições da Austrália, Américas do Norte e do Sul e da Europa, tais como as Universidades de Paris, Califórnia, Turin, Louvain, Varsóvia, Stanford, Nacional da Austrália, Autônoma do México e Buenos Aires, bem como as academias de ciências da Bulgária e da Polônia.

5. Participação em congressos

5.1 Nacionais: 15
Internacionais: 12

6. Participação em Congressos como Conferencista

6.1 Nacionais: 10
6.2 Internacionais: 8

7. Formação de Pessoal

7.1 Mestres titulados sob a minha orientação: 20
7.2 Doutores Titulados sob a minha orientação: 16

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8. Honrarias, Prêmios e Distinções

8.1 Membro da Academia de Ciências do Estado de São Paulo
8.2 Membro da Academia de Ciências do Chile
8.3 Membro Honorário do Instituto de Filosofia do Perú
8.4 Membro Titular do Instituto Internacional de Filosofia de Paris
8.5 Prêmio Moinho Santista em Ciências Exatas
8.6 Prêmio Jaboti em Ciências Exatas
8.7 Doutor Honoris Causa pela Universidade Federal do Paraná, 2001

9. Produção Científica e Cultural

Mais de duzentos trabalhos (notas, artigos e livros), com artigos em revistas tais como Comptes Rendus da Academia de Ciências de Paris, Mathematisches Zeitschrift, Journal of Symbolic Logic, Foundations of Physics, Erkenntnis e Philosophy of Science.
Relação dos trabalhos mais importantes:

1) Calculs propositionnels pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 257** (1963), 3790-3793
2) Calculs de prédicats pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 258** (1964) , 27-29
3) Calculs de prédicats avec égalité pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 258** (1964) 1111-1113
4) Calculs de descriptions pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 258** (1964), 1366-1368
5) Sur un système inconsistant de théorie des emsembles, **C.R. Acad. Sc. Paris, 258** (1964), 3144-3147
6) Sur les systèmes formels Ci, Ci¯, Di et Nfi, **C.R. Acad. Sc. Paris, 260** (1965), 5427-5430
7) On two systems of set theory, **Proceedings Nederl. Ak. Van Wetens. Amsterdan,** (1965), 95-99
8) Opérations non monotones dans les treillis, **C.R. Acad. Sc. Paris, 263** (1966), 429-432
9) Filtres et idéaux d'une algèbre Ci , **C.R. Acad. Sc. Paris, 264** (1967), 549-552
10) Two formal systems of set theory, **Proceedings Nederl, Ak. Van Wetens. Amsterdan, 70** (1967), 45-51
11) Un nouveau systéme formel suggére par Dedecker, **C.R. Acad. Sc. Paris, 265** (1967), 85-88
12) On a set theory suggested by Ehresmann and Dedecker, **Proceedings Japan Acad. Sc. , 45** (1969), 880-888
13) On the underlying logic of two systems of set theory, **Proceedings Nederl. Ak. van Wetens. Amsterdan, 73** (1970), 1-8
14) Modèles et universes de Dedecker, **C.R. Acad. Sc. Paris, 275** (1972), 483-486
15) α - models and the systems T and T*, Notre Dame Journal of Formal Logic, 14 (1974), 443-454

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16) Remarques sur les calculs Cn, Cn*, Cn$^{=}$, Dn , **C.R. Acad. Sc. Paris, 278** (1974), 819-821
17) A model –theoretical approach to variable binding term operators, in Mathematical Logic in Latin America, editado por A. I. Arruda, R. Chuaqui e N. C. A da Costa, North-Holland, 1980, pp. 131-146
18) The philosophical import of paraconsistent logic, **Journal of Non-Classical Logic, 1** (1982), 1-19
19) On paraconsistent set theory, **Logique et Analyse, 115**, (1986), 361-371
20) Pragmatic truth and approximation of truth, **The Journal of Symbolic Logic, 51** (1986), 201-221 (com Mikenberg e R. Chuaqui.)
21) Pragmatic probability, **Erkenntnis, 25** (1986), 141-162
22) An outline of a system of inductive logic, **Teoria, 7** (1987), 8-13
23) Pragmatic probability, logical omniscience and the Popper-Miller argument, **Fundamenta Scientiae, 9** (1988), 43-53 (com S. French.)
24) A note on temporal logic, **Bull. Sec. Logic Polish Acad. Sc., 18** (1987), 51-56 (com S. French.)
25) Pragmatic truth and the logic of induction, **Britsh Journal for the Philosophy of Science, 40** (1989), 333-356 (com S. French.)
26) Logic and pragmatic truth, in **Logic, Methodology and Philosophy of Science VII,** editado por J.E. Fenstad et alli., Elsevier, 1989, pp. 247-261
27) Belief, contradition and the logic of self-desception, **American Philosophical Quaterly, 27** (1990), 179-197 (com S. French.)
28) A Suppes predicate for general relativity and set-theoreticaly generic space-time, **International Journal of Theoretical Physics, 29** (1990), 935-961 (com F. A. Doria)
29) The paraconsistent logic P , **Zeitschrift f. Math. Logik und Grund d. Math. , 37** (1991), 131-148. (com V.S. Subrahmaniam e C. Vago)
30) Undecidability and incompleteness in classical mechanics, **International Journal of Theoretical Physics, 30** (1991), 1041-1073 (com F. A. Doria)
31) Classical Physics and Penrose's Thesis, **Foundations of Physics Letters, 4** (1991), 363-373 , (com F. A. Doria)
32) On the Existence of very difficult satisfiability problems, **Bull. Sect. Logic Univ. of Lodz, 21** (1992), 122-133 (com F. A. Doria)
33) A model-theoretical apptoach to "natural reasoning", **Internatinal Studies in the Philosophy of Science, 7** (1993), 177-190. (com S. French.)
34) Schorödinger logics, **Studia Logica, 53** (1994), 533-550. (com D. Krause)
35) Undecidable Hopf bifurcation with undecidable fixed point, **International Journal of Theoretical Physics, 33** (1994), 1885-1903. (com F. A. Doria)
36) On Jaskowski's discussive logic, **Studia Logica, 54** (1995), 33-60 (com F. A. Doria)
37) Logiques classiques et non classiques, **Masson**, Paris, 1997
38) Sistemas Formais Inconsistentes, **Editora da UFPR**, Curitiba, 1993
39) Aspects of paraconsistent logic, **Bulletin of IGPL, 3** (1995), 397-614 (com J.-Y.Béziau e O. A. S. Bueno.)
40) La teoria del caos y el mercado financeiro, **Información y Tecnologia, 1** (1995), 63-67. (N. A. C. da Costa Jr.)

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41) Undecidability, imcompleteness and Arnold Problems, **Studia Logica, 55** (1995), 22-32, (com F. A. Doria).
42) El conocimiento científico, UNAM, México, 2001.
43) Lógica inductiva y probabilidade, Fondo de Cultura, Lima, Perú, 2001.
44) Science and Partial Truth, Oxford University Press, Oxford, 2003 (com S. French).

10) Principais Atividades de Pesquisa

Lógicas não-clássicas, teoria dos reticulados, teoria dos modelos, fundamentos da teoria das categorias, lógica indutiva e probabilidade, física matemática e teoria da ciência.

11) Notas

11.1 Meus trabalhos têm sido traduzidos para o espanhol, o russo, o chinês, o italiano, o búlgaro e o francês.
11.2 Em 1998 foi realizado na Bélgica o Primeiro Congresso Mundial de Lógica Paraconsistente (lógica da qual fui um dos criadores). Foram realizados outros, em Torún (Polônia, 1999), no Brasil (2000) e nos Estados Unidos, 2001.
11.3 Com F. A. Doria resolvi dois dos grandes problemas da teoria do caos e da mecânica clássica: os problemas de Hirch e da quadratura (ver I. Stewart, *Nature, 352 (1991), 664-666).*
11.4 Membro Honorário da Equipe REHSEIS, Université de Paris 7, Paris.
11.5 Coordenador da Área de Lógica e Teoria da Ciência do Instituto de Estudos Avançados da Universidade de São Paulo.
11.6 Medalha Nicolau Copérnico da Universidade de Torún, Polônia, 1998, um dos mais importantes prêmios científicos do referido país.
11.7 Medalha do Mérito Científico, UFPR e AEAUFPr, 1998.
11.8 Pesquisador 1 A, CNPq.

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Professor Newton C. A. da Costa
Awarded a N. Copernicus University Medal of Merit

1. This year we celebrate the 50th anniversary of an outstanding and unusually fruitful event in the life of Nicholas Copernicus University and of Polish science. Fifty years ago, on Friday, 19 March 1948, Professor Stanisław Jaśkowski, late Rector of the University of Toruń, at the forum of *Societatis Scientiarum Torunensis* gave a lecture on the topic of discursive (or discussive) logics i.e., logics accommodating inconsistencies — allowing for discussion and investigation of contradictions. From this initiative an entire new field of modern logic has arisen!

It is important to note the revolutionary character of Jaśkowski's work. On the one hand, he accepted the destructive role of contradictions within the framework of theories based on classical logic and adhered to the view that the principle of non-contradiction is a fundamental tenet of Reason. On the other hand, by his method of dealing with contradictions he overcame the traditional fear of contradictions as well as reluctance to work with and explore them in a positive way, in search for their sources and reasons, for their explication. The fear which often occurs in rational discourse and sometimes simply paralyses Reason.

2. The efforts of Jaśkowski could however have been silenced or marginalized had not similar ideas occurred later on in minds of others. These, having been appropriately developed and propagated, evolved into paraconsistent logics, which today form one of the principal families of nonclassical logics and are particularly useful in the field of philosophy, as well as that of computer sciences, especially in Artificial Intelligence.

3. In the history of paraconsistency, a central role has been played by Professor Newton C. A. da Costa. He has also been instrumental in ensuring that the idea of Prof. Jaśkowski would not perish in Poland, nor in the place of its birth — Toruń. In the second half of the 1960s, Prof. da Costa established contacts with pupils of Prof. Jaśkowski (Profs. Lech Dubikajtis and Jerzy Kotas) and committed himself to the further development of discursive logic in Poland, first in Toruń and then also in other Polish academic centers. Among others, two present professors of the Department of Logic of N. Copernicus University also took part in this effort.

4. Professor Newton C. A. da Costa (b. 1929), mathematician, logician, and philosopher, ranks among the most distinguished Brazilian and Latin American scholars. A professor at the University of São Paulo (Brazil) as well as the University of Paris VII - Denis Diderot (France), he is one of the two (or three) co-fathers of paraconsistent logic.

He also works on, among other things, model theory, nonclassical logics in general, philosophy of mathematics, as well as philosophy and metamathematics of physics. He has published more than 200 scientific articles, mostly in leading journals of mathematical logic. He has taken part in hundreds of scientific conferences, and lectured around the world. In short, he is a scholar of world renown, deserving the wide respect he enjoys.

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5. He has played a key role in the continuation and development of one of the really important and fruitful ideas in Polish thought.

Nicholas Copernicus University remembers that what is worth of memory and esteem, and eminent to its mission and ethos. Recognizes genuine achievement!

On 27 January 1998, the Nicholas Copernicus University Senate conferred upon Professor Newton C. A. da Costa the University Medal of Merit.

Jerzy Perzanowski

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LOGIQUES CLASSIQUES ET NON CLASSIQUES

Paris, Masson, 1997

Note sur l'auteur

Newton da Costa, mathématicien, logicien et philosophe des sciences, professeur de mathématiques et de philosophie à l'université de Sao Paulo (Brésil), est une des figures essentielles de la logique contemporaine. Il est avant tout connu pour avoir développé la « logique paraconsistante », c'est-à-dire les familles de logiques qui se passent de l'axiome de non-contradiction, aujourd'hui florissantes et qui trouvent des applications à de multiples domaines des sciences exactes et des sciences humaines : il s'agit là de l'une des inventions majeures en logique dans la seconde moitié du siècle. Il a également contribué à d'autres découvertes dans les autres domaines de la logique et de la philosophie de la connaissance : en théorie des modèles, en logique algébrique, à propos de la théorie de la vérité, dans le domaine des fondements de la physique (théorème d'incomplétude pour les théories dynamiques axiomatisées, qui apparaît d'ores et déjà être, pour la physique mathématique, l'équivalent de ce qu'est le théorème de Gödel pour l'arithmétique et les mathématiques). Il est auteur de cinq ouvrages traitant de ces problèmes.

Il a publié plus de 200 articles dans les meilleures revues spécialisées (Journal of Symbolic Logic, Zeitschrift für Mathematische Logik und Grundlagen der Mathematik, Journal of Theoretical Physics, etc.) Plus de 800 articles spécialisés et de nombreux ouvrages et colloques ont été consacrés à son œuvre ou à des développements qui prennent explicitement ses résultats cmme point de départ.Étant l'un des principaux auteurs du développement de la logique en Amérique du Sud, Newton da Costa a notamment fondé la Société brésilienne de Logique et entretient des relations suivies avec les logiciens du Chili et d'Argentine, la plupart étant ses élèves. Il se rend régulièrement en Italie et en France où il dirige des recherches (équipe REHSEIS du CNRS et de l'université Paris VII-Denis Diderot). Les logiciens chinois s'intéressent de près à son travail. Il a également enseigné, poursuivi des recherches et donné des conférences dans de nombreuses universités étrangères, entre autres à Auckland, Stanford, Varsovie, Moscou, Louvain, Turin, Paris. En 1989, il a été élu à l'unanimité membre de l'Institut international de philosophie (Paris).

Note sur le traducteur

Jean-Yves Béziau a récemment soutenu une thèse de mathématique à l'université Paris VII-Denis Diderot et une thèse de philosophie à l'université de São Paulo sur des problèmes de logique. Jeune chercheur en pleine ascension, il travaille depuis de plusieurs années à l'université de São Paulo avec l'auteur. Il a également travaillé à l'Institut de logique et de mathématiques de l'université de Wroclaw en Pologne et à l'université de Californie (UCLA).

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Newton C. A. da Costa: Uma Breve Apresentação

Gostaria de iniciar minha apresentação do professor Newton da Costa de uma forma que, sendo pouco usual, talvez agrade não apenas aos presentes neste simpósio, mas também, é provável, contente o próprio apresentado: começarei pelo final. Com efeito, uma de suas características mais típicas, notável tanto em diversos aspectos de sua obra, quanto em muitas de suas atividades acadêmicas, consiste justamente no interesse e numa forma muito particular de curiosidade por aquilo que, de um modo ou de outro, foge do usual. Paradoxos, antinomias, inconsistências são itens de um vasto repertório que, em diversos aspectos, motivou (e tem motivado) parte considerável de seu trabalho. E talvez esta característica, tomada isoladamente, já revele um componente fundamental de sua obra.

Engenheiro (por formação), matemático (por habilidade), lógico (por interesse) e filósofo (pela natureza de muitas de suas investigações), Newton da Costa, ao longo de quatro décadas, tem apresentado contribuições extremamente originais a diversos domínios do conhecimento, examinando desde questões ligadas à lógica matemática até problemas vinculados aos fundamentos da física. Contudo, para os propósitos desta breve apresentação, poderíamos dividir seus trabalhos em três grandes categorias: (i) aqueles dedicados à lógica, por um lado, (ii) os que versam sobre questões relativas à filosofia das ciências (tanto empíricas quanto formais), por outro, e, finalmente, (iii) aqueles que abordam problemas de interesse aos fundamentos da física e à física matemática, em particular. Mencionarei a seguir, rapidamente, alguns aspectos de suas investigações em cada uma destas áreas.

No que se refere à lógica, disciplina para a qual muito contribuiu, publicando mais de uma centena de artigos, seus trabalhos poderiam receber nova classificação.

(a) Em primeiro lugar, no que se refere às *lógicas não clássicas*, a partir de 1954, Newton da Costa foi responsável pela criação de um novo tipo de lógica que, diferentemente da lógica clássica, não se torna trivial diante da presença de contradições: a lógica paraconsistente. Na opinião de certos especialistas, a elaboração deste sistema constituiu a maior realização no campo da lógica na segunda metade deste século. (Recentemente, sua antiga tese de cátedra na área de análise matemática e análise superior, defendida em 1963, na Universidade Federal do Paraná, intitulada *Sistemas Formais Inconsistentes*, onde expõe algumas de suas propostas acerca desta lógica, foi publicada pela editora desta mesma universidade.) Além disto, ele apresentou contribuições a muitos outros tipos de lógica, tais como (entre outras): a lógica modal, a deôntica, a jurídica, a relevante e a epistêmica.

(b) Quanto à *teoria das categorias*, Newton da Costa, em meados de 1965, foi um dos primeiros lógicos a proporcionar uma fundamentação aceitável para a mesma -- que, como se sabe, não pode ser fundamentada nas teorias tradicionais de conjuntos.

(c) No que concerne à *lógica algébrica e à teoria dos reticulados*, ele introduziu, em 1967, a noção de álgebra de Curry, o que lhe permitiu algebrizar várias lógicas não-clássicas.

(d) Relativamente à *teoria de modelos*, ele desenvolveu diversos trabalhos, tanto, a partir de 1976, no nível da teoria das valorações (que busca a obtenção de semânticas para sistemas lógicos), como, em meados de 1986, na definição do conceito de verdade pragmática, a partir do qual se estende a teoria de modelos existente. Este conceito, por sua vez, foi por ele aplicado a diversos domínios, passando do cálculo de probabilidades e da lógica indutiva, até a lógica da aceitação científica.

(e) Finalmente, no que diz respeito especificamente à *lógica indutiva e à probabilidade*, com base nesta noção de verdade pragmática, Newton da Costa definiu, em 1986, o conceito de probabilidade pragmática, chegando então a uma versão própria da concepção subjetiva da probabilidade, e estabelecendo, a partir dela, em 1987, um sistema de lógica indutiva, intimamente relacionado a questões de fundamentos da ciência. (A este respeito, ele publicou, em 1993, pela HUCITEC, em co-edição com a EDUSP, o livro *Lógica Indutiva e Probabilidade*, no qual aborda alguns aspectos envolvidos nestas questões.)

É justamente a partir deste grande quadro teórico (composto por uma noção de verdade, uma interpretação da probabilidade e uma doutrina sobre a lógica indutiva) que se assenta parte dos trabalhos por ele desenvolvidos no interior da *filosofia da ciência*. Sua concepção, denominada *pragmatismo crítico*, e exposta em diversos artigos, engloba as assim chamadas propostas estruturalistas da ciência, preconizadas por Beth, Suppes, Sneed, Stegmüller entre outros, mas as amplia, uma vez que, no seu entender, a filosofia da ciência, além da dimensão axiomático-estrutural, apresenta outras, como a histórica, e só será levada a bom termo quando cultivada de maneira integral e pluralista.

Por outro lado, ainda no domínio filosófico, com base em seus trabalhos na área de lógica não clássica, ele buscou elaborar uma *filosofia da lógica e da matemática* que desse conta dos traços característicos destas

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z określonymi restrykcjami finansowymi w trakcie realizacji grantu. Ponadto sama decyzja o podjęciu wspólnego przedsięwzięcia wymaga wzajemnego zaufania zarówno ze strony wnioskodawcy, jak i realizatora projektu celowego, bowiem ten pierwszy jest zainteresowany efektywnym spożytkowaniem poniesionych nakładów na realizację prac badawczo-rozwojowych (35% kosztów), drugi zaś profesjonalnym wykonaniem przyjętych na siebie zobowiązań badawczych. Bardzo ważnym elementem decydującym o zgłoszeniu projektu celowego jest ekonomiczny i ekologiczny aspekt przedsięwzięcia.

Bardzo dobrym przykładem jest zapewne projekt dotyczący utylizacji produktów ubocznych z przemysłu sodowego w procesie wytwarzania pełnowartościowych fosforanów wapniowo-magnezowych dla przemysłu paszowego, którego wnioskodawcą były Janikowskie Zakłady Sodowe „Janikosoda" SA. Zgodnie z obowiązującymi dotychczas reżimami technologicznymi w przemyśle sodowym, szlamy z oczyszczania solanki surowej metodą sodowo-wapienną w ilości 86.000 m³/rok, zawierające cenne składniki żywieniowe w postaci soli wapniowo-magnezowych i mikroelementów, stanowią uciążliwy odpad, odprowadzany na składowisko tzw. białych mórz oraz – kolektorem ściekowym – do rzeki Wisły. Janikowskie Zakłady tracą w ten sposób pokaźne środki finansowe, skażając jednocześnie środowisko przyrodnicze. Równocześnie na krajowym rynku paszowym występuje znaczny (około 30.000 ton/rok) deficyt mineralnych dodatków paszowych w postaci fosforanów dwuwapniowych. Deficyt ten jest częściowo rekompensowany importem fosforanów paszowych z Rosji, jednak ich parametry żywieniowe i użytkowe odbiegają od obowiązującej normy jakościowej.

W efekcie realizacji tego projektu zostanie wdrożona w omawianym przedsiębiorstwie technologia produkcji fosforanów paszowych o docelowej zdolności 15.000 ton/rok, która umożliwi całkowite zagospodarowanie szlamów odpadowych z instalacji oczyszczania solanki surowej, a ponadto pozwoli odzyskać solankę oczyszczoną (około 70.000 m³/rok) dla procesu wytwarzania sodu, co poprawi w istotnym stopniu bilans wykorzystania podstawowego surowca (chlorku sodu) w przemyśle sodowym.

Nieco inne założenie badawcze towarzyszy drugiemu programowi, dotyczącemu opracowania nowoczesnej technologii uzdatniania wody powierzchniowej z Drwęcy na potrzeby mieszkańców regionu toruńskiego, którego wnioskodawcą była Stacja Uzdatniania Wody w Lubiczu. W ramach tego projektu przewiduje się przeprowadzenie w Stacji całorocznego eksperymentu, którego podstawowym celem będzie optymalizacja procesu technologicznego z zapewnieniem nowoczesnego systemu monitorowania poziomu szkodliwych zanieczyszczeń, obejmującego następujące operacje: utleniania wstępnego ozonem, koagulacji i flokulacji, filtracji na filtrach antracytowo-piaskowych, ozonowania pośredniego, filtracji węglowej w trybie biologicznym oraz dezynfekcji chlorem lub dwutlenkiem chloru.

Prawidłowa analiza efektywności uzdatniania wody powierzchniowej z Drwęcy wymaga opracowania, specyficznej dla tego typu surowca naturalnego, oceny istotności wpływu najbardziej szkodliwych mikrozanieczyszczeń organicznych i nieorganicznych na właściwości organoleptyczne i zdrowotne wody uzdatnionej w oparciu o najnowsze wyniki naukowe i normy europejskie. Ocena ta zostanie uzupełniona o możliwie pełną inwentaryzację najbardziej znaczących źródeł mikrozanieczyszczeń, ze szczególnym uwzględnieniem czynników mutagennych w zlewni Drwęcy.

Powyższe przedsięwzięcie wymaga opracowania nowoczesnych układów monitorowania szkodliwych substancji w wodzie, dostosowanych do przewidywanego systemu sterowania operacjami uzdatniania wody. W tym celu zostaną zastosowane, obok rutynowych technik badawczych, najnowsze analizatory i procedury analityczne, m.in. spektrofotometria UV-VIS, wysoko sprawna chromatografia cieczowa (HPLC), chromatografia gazowa-spektrometria masowa (GC-MS) oraz absorpcyjna spektrofotometria masowa (ASA).

Eksperyment badawczy w ramach omawianego projektu zostanie przeprowadzony przez Zespół dr. hab. Romana Buczkowskiego, Zakład Hydrobiologii UMK oraz pracowników Laboratorium Badawczego Stacji Ujęcia Wody w Lubiczu.

Wojciech Streich

W br. przypada pięćdziesiąta rocznica wybitnego i wyjątkowo owocnego wydarzenia w życiu Uniwersytetu Mikołaja Kopernika i nauki polskiej. Pięćdziesiąt lat temu bowiem prof. Stanisław Jaśkowski, śp. rektor UMK, na forum TNT wygłosił odczyt nt. logik dyskusyjnych, tj. logik tolerujących sprzeczności. Z pracy tej wyrosła cała działka współczesnej logiki!! (szerzej piszemy o tym na str. 21 GU – red.).

Medal UMK dla prof. Newtona da Costy

Podkreślić należy rewolucyjny charakter tej pracy – akceptując bowiem destrukcyjny charakter sprzeczności w ramach teorii opartych na logice klasycznej oraz w pełni przyjmując to, że zasada niesprzeczności jest fundamentalną zasadą Rozumu, przełamywała tradycyjny strach przed pozytywnym badaniem sprzeczności, które nieraz pojawiają się w obrębie dyskursu racjonalnego, i szukaniem ich racji oraz wytłumaczenia.

Praca Jaśkowskiego mogłaby być jednakże przemilczana bądź zmarginalizowana, gdyby podobne idee nie pojawiły się później w innych umysłach i nie zostały odpowiednio rozwinięte i rozpropagowane. Wynikłe stąd logiki parakonsystentne są dzisiaj jedną z głównych rodzin logik nieklasycznych, szczególnie użytecznych na terenie filozofii (co nie dziwi) oraz informatyki, w szczególności AI – teorii sztucznej inteligencji.

W karierze idei parakonsystentności główną rolę odegrał prof. Newton da Costa. Odegrał on też główną rolę w tym, że idea Jaśkowskiego nie zginęła w Polsce i w miejscu jej narodzin – w Toruniu. W drugiej połowie lat sześćdziesiątych prof. da Costa nawiązał bowiem kontakt z uczniami Jaśkowskiego (prof. prof. L. Dubikajtisem i J. Kotasem) i przyczynił się do tego, że najpierw na terenie Torunia, a potem też w innych ośrodkach polskich badania nad logikami dyskusyjnymi podjęto i rozwinięto, m.in. dwu obecnych profesorów Katedry Logiki także zaznaczyło swój udział w tych pracach.

Prof. Newton C.A. da Costa (ur. 1929), matematyk, logik i filozof, należy do najwybitniejszych uczonych brazylijskich, o znaczeniu przekraczającym Amerykę Łacińską. Jest on profesorem Uniwersytetu w Sao Paulo (Brazylia) oraz Uniwersytetu Paryż VII-Denis Diderot, jednym z ojców logiki parakonsystentnej, pracującym też, między innymi, na polu teorii modeli, logik nieklasycznych w ogóle, filozofii matematyki oraz filozofii i podstaw fizyki. Opublikował ponad 200 artykułów naukowych (większość w czołowych czasopismach logiczno-matematycznych). Brał udział w kilkuset konferencjach naukowych, wykładał na wszystkich kontynentach. Krótko – jest uczonym o światowej sławie – znakomitym i zasłużonym! Odegrał kluczową rolę w przetrwaniu i rozpropagowaniu jednej z ważnych idei myśli polskiej.

Prof. N. da Costa w czasie odczytu w Instytucie Matematyki UMK (1 XII 1976)

Uniwersytet Mikołaja Kopernika pamięta o tym, co mu bliskie i na pamięć zasługuje. **Czci rzetelną zasługę!**

Senat UMK dnia 27 stycznia 1998 r. przyznał prof. N. da Costa medal „Za zasługi położone dla rozwoju Uczelni".

Jerzy Perzanowski

lisciplinas, tais como se encontram contemporaneamente. A este respeito, além de numerosos artigos, ele ıublicou dois livros. O primeiro deles, *Introdução aos Fundamentos da Matemática* (publicado originalmente ;m 1962), foi recentemente reeditado pela HUCITEC. O segundo, de 1980 (também publicado pela HUCITEC), *Ensaio sobre os Fundamentos da Lógica*, já se encontra em sua segunda edição, tendo inclusive recebido uma radução francesa, que será publicada, ainda este ano, com o título: *Lógica Clássica e Lógicas Não Clássicas*.

Sistematizando, a partir de toda esta obra, alguns aspectos de sua visão da ciência, tanto formal quanto ;mpírica, ele acaba de escrever um novo livro, *O Conhecimento Científico*, que em breve estará disponível ao ıúblico.

Finalmente, a partir do final da década de 1980, ele obteve com Francisco Doria, nas áreas de *teoria dos ;istemas dinâmicos, caos e fundamentos da física*, resultados extremamente significativos, resolvendo ıroblemas célebres, há muito tempo abertos nestes campos, como os de Hirsch e de Arnold. Tais resultados, ;omo não seria de se surpreender, tiveram repercussão internacional; Ian Stewart, por exemplo, comentou-os, ;m 1991, em uma das mais célebres e conceituadas revistas de ciência do mundo, *Nature*, e também em *Vonlinear Science Today*.

Tendo iniciado esta apresentação pelo final, mencionando aspectos da obra já constituída de Newton da Costa, retorno agora ao início, e concluo minhas observações indicando algumas de suas outras atividades ıcadêmicas.

Newton da Costa, a partir de 1963, foi professor catedrático, na área de análise matemática, na Universidade Federal do Paraná. Em 1971, foi nomeado professor titular do Instituto de Matemática e Estatística da Universidade de São Paulo e, em 1991, professor titular de lógica do Departamento de Filosofia da Faculdade de Filosofia, Letras e Ciências Humanas desta mesma universidade. No Brasil, lecionou em diversas instituições, a saber, a Universidade Federal do Paraná, o Instituto de Matemática e Estatística da Universidade de São Paulo, a Universidade Estadual de Campinas, a Pontifícia Universidade Católica de São Paulo e, atualmente, ensina no Departamento de Filosofia da Faculdade de Filosofia da Universidade de São Paulo. Foi professor visitante, conferencista ou pesquisador em várias intituições na Austrália, na Europa, nos Estados Unidos e na América Latina, como por exemplo: Universidades de Paris, Louvain, Varsóvia, Califórnia (Berkeley e Los Angeles), Stanford, Nacional da Austrália, Buenos Aires, Católica do Chile e Nacional Autônoma do México, bem como nas Academias de Ciências da Polônia, da Bulgária e da União Soviética.

Possui cerca de 200 artigos, notas e resumos publicados em revistas internacionais, tais como (entre outras): *Comptes Rendus* da Academia de Ciências de Paris, *Proceedings* da Academia de Ciências da Holanda, *The Journal of Symbolic Logic*, *Mathematische Zeitschrift*, *International Journal of Theoretical Physics*, *Foundations of Physics*, *Erkenntnis*, *Synthese*, *Philosophy of Science*, *American Philosophical Quarterly*, e *British Journal for the Philosophy of Science*. Editou também vários livros, publicados pela North-Holland e Marcel Dekker. Seus trabalhos têm sido traduzidos para o russo, o búlgaro, o italiano, o espanhol e o chinês.

Desde 1986, é Coordenador da área de Lógica e Filosofia da Ciência do Instituto de Estudos Avançados da Universidade de São Paulo.

Recebeu ainda o Prêmio Moinho Santista, em 1993, por suas contribuições à área de ciências exatas. Também nesta mesma área (ciências exatas), recebeu, em 1994, o Prêmio Jabuti, por seu livro *Lógica Indutiva e Probabilidade* (publicado pela HUCITEC em 1993).

É membro titular do Instituto Internacional de Filosofia de Paris desde 1989, e de diversas academias, como a Academia de Ciências do Estado de São Paulo e a Academia de Ciências do Chile.

Antes de concluir, gostaria de mencionar um último ponto. Em 1983, Karl Popper e um de seus discípulos, David Miller, publicaram uma carta, em *Nature*, "provando" (entre controversas aspas) a impossibilidade de uma probabilidade indutiva. Da enxurrada de artigos que se seguiu, contrários à pretensa demonstração popperiana, apenas um, no entender do próprio Popper, constituía uma réplica que de fato poderia abalar seu argumento. Seu autor: Newton da Costa.

Mas não me estenderei mais com estas observações. Passo agora a palavra a quem esta é devida.

Otávio Bueno

Department of Philosophy
California State University

1993

FRNKFURTER ALLGEMEINE ZEITUNG

24. MÄRZ 2001

Newton daCosta

NEWTON ist Brasilianer

Vor zehn Jahren wurde die Parakonsistente Logik offizielles Thema der Mathematik

Dr. Jens Soentgen

„Brasilien ist ein Land der Abstufungen", erklärt der brasilianische Anthropologe Roberto da Matta: „Bei uns gibt es nicht diese harten Gegensätze zwischen drinnen und draußen, wahr oder falsch, Mann oder Frau, verheiratet oder geschieden, Gott oder Teufel, schwarz oder weiß." Der Brasilianer habe vielmehr eine außergewöhnliche Fähigkeit, zwischen scheinbar unversöhnlichen Fronten zu vermitteln.

Vielleicht hängt es mit diesen Talenten zusammen, daß gerade ein Brasilianer die ersten ausgearbeiteten Systeme einer ‚Parakonsistenten Logik' entwickelt hat. Der Mathematiker Newton da Costa, geboren 1929 in der südbrasilianischen Stadt Curitiba, zeigte in seiner 1963 eingereichten Doktorarbeit, daß ein formales System, das Widersprüche enthält, nicht notwendigerweise in den Papierkorb gehört.

In der klassischen Logik werden Systeme, in denen ein Widerspruch auftritt, sofort, wie der Fachmann sagt, trivial, mit anderen Worten, nutzlos, weil sich aus einem widersprüchlichen Satz jeder andere Satz ableiten läßt. Das formale System wird dadurch beliebig, schwillt an und produziert immer weitere Widersprüche.

So wollen es die heiligen Regeln der klassischen Logik: „E contradictione quodlibet sequitur", aus dem Widerspruch kann man alles folgern, wußten schon die Scholastiker, die ihre Schlußfiguren mit klingenden Namen versahen und an theologischen Fragen ausprobierten.

Zwar hatte Aristoteles, der Begründer der klassischen Logik, in einer wenig beachteten Diskussion über das Zukünftige bereits hervorgehoben, daß von zwei entgegengesetzten Sätzen nicht notwendigerweise der eine wahr, der andere falsch sei. Dennoch setzte sich in der an ihn anschließenden Tradition das Nichtwiderspruchsprinzip neben dem Identitätsprinzip und dem Prinzip des ausgeschlossenen Dritten als eine der drei Säulen der klassischen Aussagenlogik durch. Danach können zwei sich widersprechende Sätze nicht zugleich wahr sein.

Eben deshalb tritt in der klassischen Logik nach einem Widerspruch sofort der Ernstfall ein. Findet sich in einer Zeile ein Widerspruch, dann, so lautet die Regel, kann man in der nächsten Zeile jeden beliebigen Satz, der einem in der Sinn kommt, hinschreiben: Jetzt kann man alles behaupten.

Im Alltagsleben ist das freilich anders. Wo zwei gegensätzliche Meinungen aufeinanderprallen, da ist das Ergebnis keineswegs der Zusammenbruch der ganzen Welt, sondern man einigt sich in einem Kompromiß. Wo kämen wir auch sonst hin? Jeder nicht ganz eindimensionale Mensch läuft mit Widersprüchen in seiner Brust herum, ist angefüllt mit gegensätzlichen Träumen und Wünschen. Fast alle Regelsysteme, durch die wir uns im Alltag bewegen, stecken voller Widersprüche, sei das nun die Straßenverkehrsordnung, die Deutsche Rechtschreibung (ob reformiert oder nicht), das Bürgerliche Recht, oder die Regeln und Signale des Flirtens. Solche Widersprüche machen uns in der Regel nichts aus, ja, viele wissen sie im Alltag zu ihrem Vorteil zu nutzen.

Die extreme Behandlung des Widerspruchs in der formalen Logik hat früh Kritik hervorgerufen. Immer wieder traten in der westlichen Philosophie Freunde des Paradoxen auf, zu denen auch einige Theologen wie der Kardinal Nicolaus von Cues gehört. Aber es dauerte eine ganze Weile, bis auch die Logiker auf den Gedanken kamen, sich einmal wieder dem Widerspruch zu widmen.

Der erste, der sich daran versucht zu haben scheint, ist der amerikanische Philosoph Charles Sanders Peirce, dessen darauf bezügliche Studien allerdings in seinem Nachlaß nie gefunden wurden, obwohl er sie in seinen Briefen erwähnt hat. Erste, bereits sehr weit gediehene Experimente mit der parakonsistenten Logik publizierten Angehörige der berühmten polnischen Logikerschule, vor allem Stanislaw Jaśkowski, der 1948 unter dem faszinierenden Titel „Rachunek zdan dla systemów dedukcyjnych sprzecznych" die ersten widerspruchstoleranten Kalkü publiziert hat. Die hohe theoretisch Bedeutung dieser Untersuchung wir von Kennern wie dem Konstanze Philosophen Max Urchs immer wiede hervorgehoben.

Da Costas Ansatz geht einen andere Weg als diese Pionierarbeit. Er beruh darauf, daß es in seinem Kalkül ein neue Art gibt, „Nein!" zu sagen. da Cost erfand das „weiche Nein", eine Ar „Jein" und man kann sich vorstellen daß ein Widerspruch, mit einem wei chen Nein formuliert, nicht mehr ganz so widersprüchlich aussieht. Wer es genauer wissen will, dem sei gesagt: da Costa hat das Benehmen des sogenannten Negationsoperators (¬) neu geregelt.

Wie ist nun dieses zu begreifen? Man kann sich logische Kalküle wie Kartenspiele vorstellen. So wie beim Skat jede Karte ihr eigenes Benehmen hat, und man nur bestimmte Karten aufeinanderlegen darf, so hat auch jedes Zeichen in einem logischen Kalkül seine eigenen Spielregeln. Wer eine dieser Regeln ändert, schafft ein neues Spiel, und eben dies hat da Costa getan.

Die Frage, die sich den Fachleuten daraufhin stellte, war zunächst, ob das von da Costa in Umlauf gebrachte neue Spiel nicht vielleicht mit einem schon bekannten identisch sei, sodann, wie es sich zu den bereits bekannten Spielen verhalte, und schließlich, ob es interessant genug sei, sich länger damit zu beschäftigen. Das scheint der Fall zu sein: Vor zehn Jahren entschied das Gremium der „Mathematics Subject Classification", die Aufnahme des Schlagwortes „parakonsistente Logik" unter der Chiffre 03B53. Ein unscheinbarer Vorgang, der aber für Insider viel bedeutet: Denn damit hatte das Forschungsgebiet, für das da Costa manchen Spott hat einstecken müssen, den offiziellen Segen erhalten. Der schöne Name „parakonsistent", der ein bißchen an „paranormal" oder „paramilitant" erinnert, verdankt die Disziplin übrigens dem Peruaner Francisco Miró Quesada. Der lateinamerikanische Forscher wollte mit der Bezeichnung zum Aus-

druck bringen, daß da Costas Logik ja nicht etwa schlicht inkonsistent ist, sondern vielmehr ein raffiniertes Verfahren darstellt, Widersprüche sozusagen zu unterlaufen.

Parakonsistente Logik wird heute in zahlreichen Ländern erforscht und weiterentwickelt, sie gilt als bisher wichtigster Beitrag Brasiliens zur Logik.

Die Motive, die da Costa dazu brachten, sich mit dem Widerspruch zu befassen, waren ursprünglich philosophischer Natur: „Ich wollte die Theorien von Hegel und Marx besser verstehen," sagt er. Dies ist ihm freilich, trotz aller Parakonsistenz, nur teilweise gelungen. Zwar hatte auch Hegel bekanntlich stets die „Notwendigkeit der Widersprüche" betont und die Einsicht in diese sogar zum Kriterium der „Tiefe" einer Philosophie gemacht. Gleichwohl ist kaum denkbar, daß sich Hegels hochvirtuose, für manche freilich auch unverständliche Dialektik formalisieren ließe. Der Kieler Philosoph Hermann Schmitz, ein gründlicher Kenner der hegelschen Logik, meint, es sei zwar durchaus denkbar, daß man eines Tages die hegelsche Logik ganz oder teilweise formalisieren könne: „Aber ein solcher Formalismus hätte kaum noch Ähnlichkeit mit den deduktiven Systemen, die wir heute aus Mathematik und Logik kennen, und wäre sicherlich nicht durch eine vergleichsweise so harmlose Operation zu erzeugen, wie die Änderung einiger Axiome oder Regeln der herkömmlichen Logik." Auch Hegel empfinde zwar den Satz vom Widerspruch als eine Schranke, die es zu überwinden gelte, die Pointe seiner Dialektik liege aber woanders. Nämlich in einem grundsätzlich neuen Verständnis von Wahrheit: „Das Wahre ist so der bacchantische Taumel, an dem kein Glied nicht trunken ist ...", schreibt Hegel in der Vorrede der ‚Phänomenologie des Geistes'. Die Wahrheit als Karneval? Da kommt auch die parakonsistente Logik nicht mehr mit. Der Hegel-Experte Schmitz stellt sich daher den zu Hegel passenden Formalismus gar nicht erst als einen Kalkül vor, sondern mehr als eine Folge „hinweisender Gebärden, die den Leser auffordern würden, gewisse gedankliche Übergänge zu vollziehen."

Die Anwendungsgebiete der parakonsistenten Logik liegen folglich woanders, im technischen Bereich.

Auf einem Kongreß für parakonsistente Logik, der von der Universität von São Paulo im vergangenen Jahr abgehalten wurde, präsentierten brasilianische Ingenieure stolz ein Roboterweibchen namens Emmy (nach der deutschen Mathematikerin Emmy Noether). Diese mechanische Lady hat neben anderen Vorzügen auch den, daß sie in ihrem Chip widersprüchliche Informationen prozessieren kann. Deshalb, so demonstrierten die Erbauer, läuft sie im Gegensatz zu anderen Robotern und manchen Menschen nicht gegen Glastüren, weil sie mit den widersprüchlichen Informationen, welche die optischen und die akustischen Sensoren liefern, auf parakonsistente Weise umgehen kann.

Dennoch stecken die technischen Anwendungen der parakonsistenten Logik noch gänzlich in den Anfängen – verglichen mit anderen nichtklassischen Logiken, wie etwa der Fuzzy Logic, die schon in der Software der Waschmaschine zu finden ist oder in S-Bahnen für ruckloses Bremsen und Anfahren sorgt. Die Pointe der Fuzzy Logic, die von dem russisch-jüdisch-türkisch-iranisch-stämmigen US-Amerikaner Lotfi Zadeh entwickelt wurde, ist nicht ein neues Nein, sondern eine kontrollierte Aufweichung der Wahrheitswerte, so daß es hier auch Halbwahrheiten gibt.

Die Fuzzy Logik läßt sich mit der Parakonsistenten Logik verbinden. Es ist daher denkbar, daß diese sich als Trittbrettfahrerin über die Vertriebswege, die die Fuzzy Logic bereits im Markt angelegt hat, weiterverbreitet. Auch in Deutschland wird mittlerweile über parakonsistente Kalküle geforscht, so etwa an der Universität Konstanz, am Lehrstuhl von Professor Max Urchs, oder auch an der Universität Dortmund.

Daß Widersprüche nicht immer destruktiv sein müssen, das beweist schon die schiere Existenz da Costas. Denn als typischer Brasilianer ist er eine Synthese aus nordeuropäischen und südländischen Anteilen, er zählt zu seinen Ahnen Dänen, Franzosen, Portugiesen, sogar einen Preußen. So hybrid wie sein Stammbaum ist seine Logik. Einerseits ist sie ganz akkurat gearbeitet, zugleich ist sie flexibler als die bekannten Kalküle. Charmante Lockerheit und kritische Reserve mischen sich auch in da Costas Charakter. Vom brasilianischen Sichdurchschlängeln, das auch eine Möglichkeit ist, mit Widersprüchen umzugehen, hält er trotzdem nichts: „Für einen Brasilianer bin ich sehr deutsch, lege großen Wert auf Genauigkeit," sagt er. Daher habe seine Logik auch nichts mit dem berühmten brasilianischen „jeitinho", dem lockeren Schummeln im täglichen Leben zu tun. Denn das „jeitinho", so da Costa, funktioniere nur in den Tropen. Die parakonsistente Logik dagegen „ist universal." ■

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Charakterisierung der Parakonsistenz

Sei $\vdash$ eine Relation einer logischen Konsequenz. Dann kann $\vdash$ semantisch, beweistheoretisch oder auf andere Weise definiert werden.

Die Relation $\vdash$ ist *explosiv*, wenn für alle A und B gilt: $\{A, \neg A\} \vdash B$.

Eine Relation ist *parakonsistent*, wenn sie nicht explosiv ist. Eine Logik ist parakonsistent, wenn ihre Konsequenzrelation parakonsistent ist. Eine Logik kann mehrere Konsequenzrelationen enthalten. In diesem Fall sollen alle Konsequenzrelationen parakonsistent sein.

Eine Menge von Aussagen Σ heißt *trivial*, wenn für alle B gilt: $B \in \Sigma$.

Parakonsistente Logiken sind nun gerade – falls die Konsequenz transitiv ist – solche Logiken, die inkonsistent, aber nicht trivial sind.

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Newton da Costa is, I think, one of the scientists in Brazil best known in Europe and North America. There are several reasons for this. One is that he has been a productive and creatively original scientist for many decades. A second is that he has worked in more than one field. His work in the foundations of mathematics, especially his work in what is known as paraconsistent logic, is well known. But he has also written original and significant papers on the foundations of classical mechanics and related topics in physics. There are other contributions to numerous to mention. A third and separate factor, of great importance in any country, is the large number of excellent students, now practicing scientists on their own, that he has nurtured and trained. Among my scientific acquaintances in many countries, I scarcely know of anyone who has done a better job of this critical kind of scientific education than Newton da Costa.

My best wishes to him on this celebratory occasion.

Patrick Suppes

Stanford University

Arquivos Históricos em História da Ciência (CLE/Unicamp)

De: "Valentin A. Bazhanov" <vbazhanov@yandex.ru>
Assunto: **[Spam] Paper for the Dictionary**
Data: 31 de julho de 2006 4h49min50s GMT-03:00
Para: Da Costa <ncacosta@usp.br>, ncacosta@terra.com.br
Responder A: "Valentin A. Bazhanov" <vbazhanov@yandex.ru>
1 Anexo, 102 KB Salvar

Dear Newton,

Attached find my paper "Da Costa, N.C.A." (in Russian) for the Dictionary of Analytical Philosophy (in .pdf format). The paper is rather concise for the limit of papers characters (it is Dictionary, not Encyclopaedia), though its circulation would exceed that of possible Encyclopaedia - it might be the next step.

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Sincerely yours Valentin A. Bazhanov

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Да Коста (Da Costa) Ньютон Карнейро Аффонсо (род. 16.09.1929) – бразильский логик и философ науки, заложивший основы паранепротиворечивой логики и внесший большой вклад в развитие неклассических логик.

Учился инженерному делу и математике в ун-те Параны (Бразилия). В 1961 г. получил степень доктора философии (там же). С 1961 по 1970 гг. являлся профессором ун-та Параны, с 1970 – профессор ун-та Сан Пауло. Член Бразильской, Чилийской, Перуанской АН, кавалер медали Н. Коперника (от ун-та в Торуни, Польша).

В начале 1960-х гг. независимо от Н.А. Васильева (1910) высказал идею и построил логику, толерантную к противоречию, получившую позднее название паранепротиворечивой. Фактически с работ Да Косты и в русле его идей начинается интенсивное развитие формальных систем, в которых в тех или иных пределах допускается противоречие. Вслед за латино-американской школы неклассической логики возникают центры исследования паранепротиворечивых логик в Австралии, Италии, Польше, США и др. странах.

Идеи паранепротиворечивости распространены Да Костой на области, связанные с философией науки, индуктивной логикой и теорией вероятностей, программированием, созданием искусственного интеллекта, теориями моделей, сложности, квантовой и

релятивистской механиками.

Вместе с учениками им продемонстрирована неразрешимость одного из вариантов теории динамических систем.

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В.А. Бажанов

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Vita of Prof Newton C. A. da Costa

1. Personal Data:

Full name: Newton Carneiro Affonso da Costa
Date of birth: September 16, 1929

2. Graduation

- Civil Engineering, Federal University of Paraná, Brazil, 1952
- Bachelor of Mathematics, Federal University of Paraná, Brazil, 1955

3. Pos-Graduation

- Ph.D. in Mathematics, Federal University of Paraná, Brazil, 1961

4. Teaching and Research Activities

- Full Professor of Mathematical Analysis, Federal University of Paraná, Brazil, 1961-1970;
- Full professor of Mathematics, University of São Paulo, Brazil, 1970-1982;
- Full professor of Logic and Theory of Science, Department of Philosophy, University of São Paulo, Brazil, 1982-1999;
- Visiting professor, Researcher or occassional Lecturer in several institutions, for example the following: Universities of Campinas (Brazil), Lisbon, Madrid, Paris, Lille, Louvain, Turin, Naples, Munich, Warsaw, California, Stanford, Mexico, Buenos Aires, National of Australia and Chile, and Academies of Sciences of Bulgaria and Poland.

5. Prizes and Distinctions

- Member of the Academy of Sciences of the State of São Paulo;
- Member of the Academy of Sciences of Chile;
- Honorary Member of the Institute of Philosophy of Peru;
- Member of the International Institute of Philosophy of Paris;
- Prize "Moinho Santista" in Science (Brazil);
- Prize "Jabuti" in Science (Brazil);
- Doctor Honoris Causa, Federal University of Paraná, Brazil;
- Nicholas Copernicus Medal, University of Torun, Poland.
- Doctor Honoris Causa, University of Timisoara, Romania

6. Publications

- More than 250 works (notes, papers and books) published in journals like The Comptes Rendus of the Paris Academy, Journal of Symbolic Logic,

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Mathematisches Zeitechrift, Foundation of Physics, Ekrentnis and Philosophy of Science, and in book form. Some of the most important are the following:

1) Calculs propositionnels pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 257** (1963), 3790-3793;
2) Calculs de prédicats pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 258** (1964) , 27-29;
3) Calculs de prédicats avec égalité pour le systèmes formels inconsistants, **C.R. Acad. Sc. Paris, 258** (1964) 1111-1113;
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15) α - models and the systems T and T*, Notre Dame Journal of Formal Logic, 14 (1974), 443-454;
16) Remarques sur les calculs Cn, Cn*, Cn$^{=}$, Dn , **C.R. Acad. Sc. Paris, 278** (1974), 819-821;
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18) The philosophical import of paraconsistent logic, **Journal of Non-Classical Logic, 1** (1982), 1-19;
19) On paraconsistent set theory, **Logique et Analyse, 115**, (1986), 361-371;
20) Pragmatic truth and approximation of truth, **The Journal of Symbolic Logic, 51** (1986), 201-221 (with Mikenberg e R. Chuaqui.);
21) Pragmatic probability, **Erkenntnis, 25** (1986), 141-162;
22) An outline of a system of inductive logic, **Teoria, 7** (1987), 8-13;
23) Pragmatic probability, logical omniscience and the Popper-Miller argument, **Fundamenta Scientiae, 9** (1988), 43-53 (with S. French.);
24) A note on temporal logic, **Bull. Sec. Logic Polish Acad. Sc., 18** (1987), 51-56 (with S. French.);
25) Pragmatic truth and the logic of induction, **British Journal for the Philosophy of Science, 40** (1989), 333-356 (with S. French.);

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26) Logic and pragmatic truth, in **Logic, Methodology and Philosophy of Science VII,** edited by J.E. Fenstad et alli., Elsevier, 1989, pp. 247-261;
27) Belief, contradition and the logic of self-desception, **American Philosophical Quaterly, 27** (1990), 179-197 (with S. French.)
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30) Undecidability and incompleteness in classical mechanics, **International Journal of Theoretical Physics, 30** (1991), 1041-1073 (with F. A. Doria),
31) Classical Physics and Penrose's Thesis, **Foundations of Physics Letters, 4** (1991), 363-373 , (with F. A. Doria),
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36) On Jaskowski's discussive logic, **Studia Logica, 54** (1995), 33-60 (with F. A. Doria),
37) Logiques classiques et non classiques, **Masson**, Paris, 1997;
38) Sistemas Formais Inconsistentes, **Editora da UFPR**, Curitiba, 1993,
39) Aspects of paraconsistent logic, **Bulletin of IGPL, 3** (1995), 397-614 (with J.-Y. Béziau and O. A. S. Bueno.),
40) La teoria del caos y el mercado financiero, **Información y Tecnologia,** 1 (1995), 63-67. (with N. A. C. da Costa Jr.),
41) Undecidability, imcompleteness and Arnold Problems, **Studia Logica, 55** (1995), 22-32, (with F. A. Doria),
42) El conocimiento científico, UNAM, México, 2001;
43) Lógica inductiva y probabilidade, Fondo de Cultura, Lima, Perú, 2001;
44) Science and Partial Truch, Oxford, University Press, 2003 (with S. French).

7. Areas of Research

- Non classical logics, lattice theory; model theory, inductive logic and probability, mathematical physics and the philosophy of science.

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Scientific Knowledge

Review of N. C. A. da Costa, *O conhecimento científico*, São Paulo, Discurso Editorial, 2a. ed., 1999, 300pp.
Mathematical Reviews: 2001f:03017

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Who is Newton da Costa, logician and "scientific philosopher"? What are his thoughts about scientific knowledge? This book, a "unifying summary of what has been achieved in the field of the philosophy of science", according to its author, answers these questions in five chapters, three appendices, and an interview. Appended to the chapters are complementary notes, some of them quite brief, which give readers more information about certain notions that are evoked but not treated, or are treated more briefly, in the main text, and which are written in the same spirit as the latter. The appendices also consist of such notes. For the most part, the notes were written by da Costa's collaborators. In fact, one of the characteristics of his way of working is to serve as the head of teams that combine various talents.

This book is actually much more than the summary evoked above. The author's open approach embraces a variety of horizons, and thus one should be wary when reading the book—and the present review—of the philosophically oriented labels that are associated with certain terms: the positions that they indicate are always tempered by other influences, the strongest of which could perhaps be simply that of the implicit philosophy of most of the scientific community today.

Therefore, this review concerns what is in sum a book about the philosophy of knowledge whose specific considerations encompass a vast range of areas of scientific knowledge. This philosophy of course includes an up-to-date and equally comprehensive philosophy of mathematics, which covers every scientific theory that can be expressed via formulas and axioms. But these scientific theories are merely mentioned, or we are given only the axioms and sometimes a few theorems about their rudiments; rarely does the treatment go beyond a couple of pages of commentary containing a few mathematical proofs of disparate results. Such mathematical details are not mere allusions included for their own sake, since they are used to support the philosophical argument; in the best of these cases, the philosopher will find an initiation to a topic that may be of interest in itself, accompanied sometimes by some historical data, or by some striking result, and always by references that can guide one to a deeper understanding.

We will merely mention the subjects touched upon: the results presented in the text have already been reviewed.

That the second edition of this book has come so quickly after the first [1997] is not surprising: the book has a very didactic character. The presentation of the ideas and arguments follows broad lines, what the author calls a "schematic" approach. He expresses his opinions very clearly, and, provided that one has a bit of training in philosophy (including the notions of modern logic) and a taste for musings of this sort, the book is easy to read.

The architecture of the argumentation, apart from some more detailed material that is given later, is already apparent in Chapter I, entitled "Science and knowledge". Knowledge is belief that is asserted and justified. It is scientific knowledge when it is included in a scientific theory, as an idealized system of knowledge arrived at rationally; in this idealized conception, scientific knowledge is closed under logical deduction. Therefore, scientific knowledge may be of various strengths, depending on the notion of truth, the kinds of justification, and the logic on which it is based.

The rudimentary beginnings of a classification of the sciences develop from this basis. The "formal sciences" are the subject of a more in-depth discussion in Chapter II. These sciences—mathematics and logic, which are based on each other—lose in their theorization (but not in their genesis or in their applications) their connection with experience, because, as mathematics (which from this angle encompasses logic), they consist in the study of conceptual systems, i.e., the idealized systems of knowledge evoked above (or set-theoretic structures interpreting them). In this role, these sciences are therefore in the position of taking truth to be conformity to what is ("a la Tarski", but the author also recalls Aristotle), and justification to be proof, and, in the final analysis, when it comes to inferences, to "self-evidence". These are the characteristics that confer the greatest "force" on such knowledge.

The other sciences are empirical. These are discussed in depth in Chapter IV. They all rely more on experience than on reason. The latter "neither copies nor depicts the universe, the real; it creates, weaving together webs of concepts that serve as reference lines, as coordinates, in order to orient us in circumstance"—it is assumed that these webs capture some aspects of reality in some objective region. This is why these sciences do not attain truth in the sense of conformity to what is, and from this point of view are therefore, strictly speaking, false.

But, as the author illustrates with numerous arguments drawn from the current state of science, the empirical sciences do not aim at this kind of truth, but rather at "practical" truth—da Costa calls it "pragmatic" truth, also labeling this notion as "quasi-truth". He devotes most of Chapter III, entitled "Truth", to a discussion of his own definition of this notion, and to the definition of its syntactical counterpart, the notion of truth as coherence (with propositions "acquired" previously).

Knowledge that is true in practice is true up to the degree of precision of the measures that confirm it; from this point of view, it "saves appearances" and always remains correct, even after having been surpassed by more elaborate theories. Its "falsification" ("in practice") serves only to better define, i.e. to

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restrict, its domain of validity. To justify this kind of knowledge, it is necessary to turn to induction, to "inductive logic", whose inferences (by analogy, etc.) do not always guarantee that truth is transmitted from the premisses to the conclusion. Thus, this justification can be complete only by recourse to experimental verification, which in its turn rests on, among other things, probabilistic evaluations of degrees of confirmation.

This is where, depending on the degree of probability that can be reached in general, the natural sciences, which demand a high level of probability, separate from the social sciences, which cannot demand as much (they also separate in terms of their subject matter, according to some allusions made by the author; the reviewer notes that, otherwise, we would run the risk of misclassifying meteorology as one of the social sciences).

The author's answers to the traditional problems concerning knowledge, whose metaphysical presuppositions he claims to accept, cover mostly what we have discussed above. Moreover, the categories are included among the conceptual tools that are indispensable to thought: the author follows Einstein in affirming that they are in no way immutable and have been modified throughout history.

In fact, on numerous occasions, from the introduction onward, da Costa insists on the importance of the historical context for a good understanding of science, which is conditioned by historical factors that determine its direction. The importance of social, economic and psychological factors is also underlined, although this book is limited to aspects of the development of science that are independent of those factors.

Chapter II begins with a detailed historical review of the transformations that mathematics and logic have undergone since the beginning of the nineteenth century, a process crowned by the reduction of mathematics to set theory and, following the foundational crisis, the rise of the formalized axiomatic method as advocated by Hilbert. "In the work of Bourbaki", says the author, "for the first time in the history of mathematics, this science was explicitly conceived as having as its object the study of forms", the latter term being one that da Costa often uses to refer to set-theoretic structures. The difficulties that arise in category theory and its relations with set theory lead him to conclude that "everything suggests that a unique and definitive system for founding mathematics does not exist. Mathematics and its foundations are ... in a dialectical relation, each depending on the state of evolution of the other, following different directions, in principle. And Godel's incompleteness theorem fully confirms this conclusion."

As a branch of pure mathematics, the part of logic that deals with deduction provides the canon of the deductive mechanism. Readers will not be surprised by the importance that da Costa, the creator of the systems of paraconsistent logic and its principal promoter, accords to logics (modal, etc.) that complement classical logic, and then to various kinds of heterodoxical logics, with the first place given to intuitionistic logic and the various quantum logics and nonreflexive logics that appeared during the first third of the twentieth century (nonreflexivity here concerns identity; a note of D. Krause, at the end of Chap-

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ter I, discusses these logics and the theory of quasisets). The fields of application of these logics are briefly described; the author recalls that some of the systems of paraconsistent logic may also be classified as readily among the complementary logics of classical logic (thanks to the trick of double negatives) as among heterodoxical logics.

The reader will find, among the notes that follow Chapter II, a brief historical sketch of paraconsistent logic written by O. Bueno, and a more developed note on multideductive logics and their applications written by E. G. de Souza. References to this notion, in the rest of the work, lie at the heart of da Costa's thought.

Within a multideductive logic there coexist several primitive notions of logical consequence, and the author studies the notion of logical consequence that results when these primitive notions are simultaneously taken into account: a multideductive consequence is deducible in the sense of at least one of the primitive notions. The resulting system is in general paraconsistent; it is designed to be applied, in physics, to Bohr's theories of the atom and to the wave-particle duality associated with elementary particles.

Chapter III begins with a philosophical refutation of the idea that the truth attained by the empirical sciences conforms to what is. Not only does the history of science show us that all knowledge in this realm is doomed to be surpassed some day and thus recognized as false from that point of view, but also, one can only compare one thought with another. The definition by postulates of the notion of satisfaction, introduced by Tarski and expanded by Kripke and his successors, consists of such a comparison, and is what should be imitated. Da Costa then discusses the ideas of pragmatic philosophers concerning truth, and introduces his definition of the notion of pragmatic truth [J. Symbolic Logic 51 (1986), no. 1, 201–221; MR0830086 (88c:03004)]: a simple pragmatic structure is the analogue of an ordinary structure, except that the relations (and functions) considered are not necessarily total, and that one fixes a set of statements that are (interpreted as) "acquired". A statement is said to be pragmatically true (in a pragmatic structure) if there exists an ordinary structure, having the same domain, with total relations (and functions) extending those of the pragmatic structure, which satisfies the "acquired" statements and the given statement. Such expansions (which exist under conditions that one can find in the article cited above) can be seen as so many "possible worlds"; this allows the author to characterize as pragmatically valid those formulas for which the "possibility" of their universal closure is a theorem in the system of modal predicate calculus with necessary equality, $S5Q^{=}$, which is complete for the semantics described; these formulas are the theorems of the "discursive" logic of Jaskowski associated with the above logic. This paraconsistent logic allows the definition of the notion of a pragmatic theory according to the usual formulation.

This chapter is followed by two informative notes by J.-Y. Beziau on universal logic and the theory of valuations, and then by a note by da Costa on the relations among paraclassical, discursive and multideductive logics; the latter is an extension of the former.

Chapter IV opens with reflections about the factors conditioning observa-

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tion and experimentation, and the difficulties of our contact with reality. The author notes the "theoretical pluralism" of physics in its current state (in the subsequent chapter the same remark is made about logic). Generalizing Bohr's complementarity principle, da Costa posits that the description and explanation of certain domains of reality require different, sometimes opposite, conceptual systems, possibly founded on nonclassical logics. Generalizing Bohr's correspondence principle, he posits that if two theories apply to the same realm of knowledge, one of them must be an approximation of the other and must encompass it, under certain limits. Da Costa is not afraid to affirm that complementarity and correspondence (in that sense) are part of the nature of the conceptual systems of physics. According to him, a physical theory can be, properly speaking, neither corroborated, as required by Carnap, nor falsified, as required by Popper, if we ask that truth conform to what is. He adds that "From the moment that physics uses ... mutually incompatible cognitive systems, the logic of physics, taken as a whole, is in fact paraconsistent."

In the abstract, a physical theory is characterized as containing a structure in the usual sense, a domain of knowledge, and a simple pragmatic structure of which the former structure is an expansion, and whose "acquired" statements also take into account the techniques and processes establishing the links between this theory and experience.

How do theories come to be established and accepted? It is here that the author treats methods of reasoning by induction. He includes the hypothetico-deductive method, to which one turns when intuition suggests a theory that one decides to accept in order to test its consequences. Nothing could be more rational: "we trust a theory while mistrusting it". However, a critical attitude to the theory and a concern for its experimental verification are never abandoned.

We turn to probabilities in order to evaluate the conclusions. Two probability theories are introduced, depending on the degree of precision that is required of the probabilities. The author proposes that they be adapted to the systematic use of quasi-truth.

This chapter is followed by three notes, two of which are longer: one on "inductivism", by Bueno, and the other on recent developments of the formal theory of learning, by Bueno and A. M. N. Coelho.

In Chapter V, the author speaks of, among other things, the "critical dimension" of scientific rationality, saying that it cannot be reduced to formalization and axiomatization; it is an informal activity, a critique of ideas, of presuppositions, of language, etc. Later, in order to justify the irrevocability of the advance of formalization and axiomatization, da Costa concludes, from a theorem of Sitnikov and Alekseev and from the work of G. J. Chaitin [Algorithmic information theory, Cambridge Univ. Press, Cambridge, 1987; MR0917482 (89g:68022)], that there exist particular cases of the three-body problem in which the motion of one of the bodies is random even though the system is "deterministic". Similarly, at the metatheoretical level, da Costa, along with F. A. Doria, showed [Internat. J. Theoret. Phys. 30 (1991), no. 8, 1041–1073; MR1122018 (92h:03065)] that there is no algorithm for deciding, from the equations of a dynamical system, whether the system is chaotic or not, or for deciding, from a

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given Hamiltonian, whether it can be integrated by quadratures. Other results of the same type, concerning problems in biology [N. C. A. da Costa and F. A. Doria, Philos. Natur. 31 (1994), no. 1, 1–24; MR1421312 (97g:03008)] and economics [M. Tsuji, N. C. A. da Costa and F. A. Doria, J. Philos. Logic 27 (1998), no. 6, 553–568; MR1663392 (2000b:91017)], have since been obtained. The obvious philosophical importance of these results merits the publication of their proofs in complete detail.

Finally, da Costa concludes by proposing a method for the unification of physical theories which was evoked earlier in the text, and which could consist of treating them in paraconsistent logic—multideductive, for example.

Appendix I consists of notes by N. Papavero on formalized theories in biology, by N. C. Caiero on the axiomatic method in economics, and by M. Tsuji on the incompleteness of finite mathematical structures (noncomputability of Nash equilibria).

Appendix II is devoted to notes by Doria on Godel incompleteness in the axiomatizable sciences, and on the "mathematics of man", in fact population dynamics, market equilibrium, and the relation between the undecidability results obtained and "Smale's eighth problem" [Nonlinear Sci. Today 1 (1991), no. 1, 1, 3, 12–17 1118361]; there follows a note (by da Costa) on quantum computer science, complementarity, and the adaptation of Boolean models to Takeuti's quantum set theory.

Appendix III consists of five notes: on a theory of paraconsistent sets (with a treatment of Russell's paradox), on pure logic versus applied logic, by C. A. Knudsen, on the axiomatization and structure of evolutionary biology (populations, epidemics, etc.), by J. C. M. Magalhaes, and on science and objectivity, by da Costa, followed by some additional remarks underlining the importance of certain references and pointing out some recent progress that is not mentioned in the main text.

Da Costa's arguments are solid, because they integrate, much more profoundly than other philosophers have done so far, some of the most compelling data found in modern science. Anyone wishing to refute any aspect of this discourse will need to forge some solid philosophical weapons.

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