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Translated from Polish[1]
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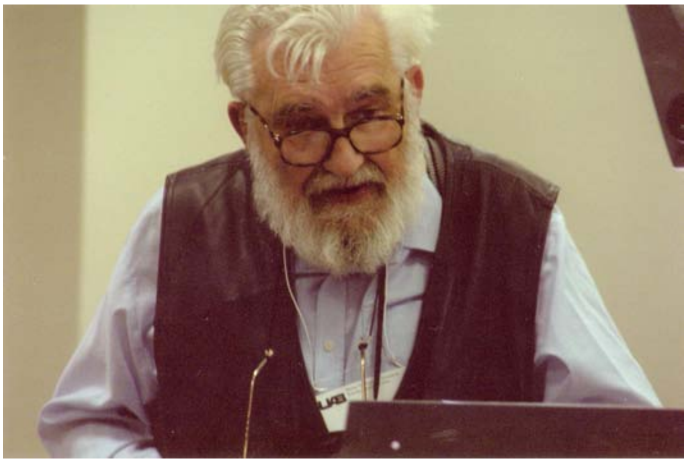
JANUSZ JERZY CHARATONIK (1934 - 2004)

PAWEŁ KRUPSKI



Janusz Jerzy Charatonik was born on the 24th of May, 1934, in Przemyśl, Poland. His father, Włodzimierz, and mother, Maria Wojdyłło, were both post office employees. After the war, the family moved to Lower Silesia, initially settling in Świdnica, where Janusz completed his elementary education. In 1948, they moved to Wrocław where Janusz attended the 5th High School of Wrocław, from which he graduated in 1951. According to his reminiscences,

[1]This article, in its original form, was published in Wiadomości Matematyczne (Mathematical News) **41** (2005), 125–150.

he first became interested in mathematics as a 12 year old, prompted and encouraged by his father. He participated in the first two Polish Mathematical Olympiads, in the second of which, in 1951, he received an award. The same year, he began his mathematical studies at the University of Wrocław, graduating in 1955, after completing his master's thesis *On estimates of some coefficients of power series of analytical functions with a pole*, supervised by Witold Wolibner. Immediately thereafter, Janusz was directed to take a one-year teaching position at the Technical High School of Finances in Opole.

Upon his return to Wrocław in 1956, Janusz began working for the University of Wrocław, committing himself to a life-long cooperation with the Mathematical Institute. His first position was that of an assistant, initially in Professor Hartman's Department of Mathematical Analysis, and a year later in the Department of Geometry, led by Professor Bronisław Knaster. It was at this time that Janusz began topological research. Under the supervision of Knaster, he completed his Ph.D. thesis entitled *On dendroids*. The work was defended in 1965. Five years later he received the habilitation degree for the dissertation *Research in acyclic curve theory*. In 1978, he was given the title of "extraordinary professor," and 10 years later, "ordinary professor." Parallel to the achievements of academic titles and degrees, Janusz was gradually promoted, finally becoming a full professor. In 1969, he was hired to be the director of the Department of Topology in the Institute of Mathematics, and he fulfilled the duty until 1997. Between 1973 and 1975, he was vice-dean of the Faculty of Mathematics, Physics and Chemistry, and later, in 1978, took the post of vice-director of the Mathematical Institute. Outside the University, he worked for the Institute for Teacher Training and Educational Research (1975-1981) and for the Pedagogical University of Opole (1981-1992).

Janusz was an active member of two scientific societies: The Polish Mathematical Society (PTM) and The Wrocław Scientific Society (since 1970). He joined the PTM in 1961, and in the term 1963-1965, he was a secretary of the Wrocław branch, and in 1975, he became a member of the management board, working in the committee for history and higher education. In addition to the American Mathematical Society (AMS), Mexican Mathematical Society, and New York Academy of Science, he was also a member of various other significant commissions and committees, such as the committee for terminology at the Polish Academy of Sciences.

Janusz enjoyed travel; the number of both domestic and foreign conference trips well exceeds 100. The first significant position held abroad was in the U.S.A, as a visiting professor during the academic year of 1967/68, in two universities: the University of Kentucky in Lexington and the University of Notre Dame. During this stay, he established many important contacts with American topologists. Among other significant international experiences were his stays in Sicily, at the University of Catania (1986 and 1991) and Messina (1988 and 1991), which resulted in the publication of several articles written in cooperation with the Sicilian mathematicians. In the early 1990s, a group of Mexican topologists, (Alejandro Illanes, Sergio Macías, Isabel Puga) from the National Autonomous University of Mexico (UNAM), initiated a cooperation with Janusz. His knowledge and open mind were highly valued by his Mexican colleagues. Upon their invitation in 1995, Janusz moved to Mexico, with his wife and son Włodzimierz, where he stayed for the rest of his life.

It was in Mexico that Janusz found a suitable environment for further professional development. Freed from the often burdensome organizational issues and too many teaching obligations, he was able to dedicate his time to intense research. The result of this was the completion of more than 150 publications. Other activities at UNAM included conducting a seminar in continuum theory, giving monographic lectures, and advising MSc candidates and his last doctoral student. Often invited to lectures and conferences in Mexico and in the United States, Janusz remained actively involved in the organization of international events - the last one of which, a large session during the meeting of AMS in Texas, took place two months before his death.

He received a number of important awards for his academic achievements, among which were three from the Polish Ministry of Education, and the Sierpiński Award granted by the Polish Mathematical Society.

Janusz was very hard working, able to combine both research and teaching, always finding time for his students and offering them a variety of intriguing problems. Under his supervision, an "uncountable" number of master's theses (> 200) have been written, some of them quite significant. Many of their authors successfully pursued academic careers, not only in the field of topology. In the years 1973-1990, Janusz had 10 Ph.D. students; the last one, in Mexico, defended her thesis in 2002. Unofficially, he was the advisor of another two doctoral candidates who received their degrees in Athens, Greece, and in North Korea.

Janusz married Marianna Kalota, a mathematics teacher, in 1956. Their children, Włodzimierz, Janusz, Witold, Aleksandra, and Tomasz, are all mathematicians or computer scientists and graduates of the University of Wrocław. Włodzimierz, his eldest son, decided to follow his father's career path–coauthoring with his father more than 60 papers. He is currently a Professor at the University of Missouri-Rolla.

Since the late 1980s, Janusz had experienced heart problems. Although he suffered three heart attacks, he remained very active–well visible in the rapidly growing number of works published in the last years of his life. He died from a heart attack in his apartment in Mexico on the 11th of July 2004, only a few days before a planned trip to Poland. His ashes were laid at the Grabiszyński cemetery in Wrocław.

1. RESEARCH

The list of publications here enclosed is impressive, yet still incomplete. Thus, only some achievements shall be discussed.

JJC's[1] mathematical interests were strengthened at the legendary topology seminar of Knaster. To understand the influence that Knaster had on the participants and the general atmosphere present during the meetings, one should become familiar with a couple of articles from Wiadomości Matematyczne.[2] Other invaluable sources are historical protocols, which had been kept during the entire duration of the seminars. They are currently to be found in the Topology Department.

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[1]The initials JJC were used by Janusz J. Charatonik himself and by his close circle of mathematicians.

[2]Compare articles by W. Nitka in Wiadomości Matematyczne 19 (1975) and by R. Duda and J. Mioduszewski in Wiadomości Matematyczne 25 (1983).

JJC first attended Knaster's seminar on the 3rd of October 1956, becoming a regular participant and taking over the leadership after Knaster's death in 1980. One of the main objectives for the meetings in that period was to take up systematic research on acyclic curves. A *curve* is a one-dimensional metric continuum, and acyclicity was understood by Knaster as *hereditary unicoherence*, i.e., non containing two subcontinua with not connected intersection; more descriptively, we can say that every two points can be joined by only one irreducible curve (i.e., a minimal continuum containing them).[3] The simplest, well-investigated, but still rich in their topological structures, acyclic curves are locally connected ones, that is, dendrites. Knaster very accurately proposed investigating more general objects: curves in which arcs are the only irreducible continua joining points; he called them *dendroids*, and then λ-*dendroids* in which such irreducible continua are of type λ[4] (a continuum is of type λ if every one of its indecomposable[5] subcontinuua has empty interior). The importance of the class of dendroids was confirmed by the fixed point property proved by Karol Borsuk in 1954. It is not hard to show that all dendrites are dendroids and that all dendroids are λ-dendroids. In [9], a nice characterization of λ-dendroids as hereditarily decomposable and hereditarily unicoherent continua is proved. Later,[6] it turned out that the class of λ-dendroids is contained in another (very important in geometrical topology) class of curves with trivial shape, i.e., tree-like continua.[7]

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[3]Now acyclicity means that there is no essential (i.e., not homotopic to a constant) mapping onto a circle. Acyclic curves are hereditarily unicoherent, and for hereditarily decomposable continua, i.e., for which each nondegenerate subcontinuum is the union of two proper subcontinua, the two notions are equivalent. It is also known that hereditary decomposability of continua implies their one-dimensionality.

[4]The terminology is connected to the Kuratowski theory of upper semi continuous monotone decompositions of irreducible continua onto an arc.

[5]A continuum is indecomposable if it is not the union of two proper subcontinua.

[6]H. Cook, 1970.

[7]A continuum is tree-like if it is an inverse limit of trees (= one dimensional connected, acyclic polygons) with continuous bonding mappings. Tree-like continua are acyclic.

1.1. Four notions

In papers [2]-[4], which formed JJC's Ph.D. dissertation, the name *dendroid* was first used and four new, and soon proved to be very important for continuum theory, notions are defined: degree of non local connectedness, uniform arcwise connectedness, smoothness, and confluent mappings. All four were first considered for dendroids only, but then were generalized for arbitrary continua and investigated by many topologists; now they are frequently used in continuum theory.

The degree of non local connectedness is an ordinal number that is equal to 0 for locally connected continua, ∞ for continua without points of local connectedness, and for all other continua, intuitively speaking, it is the length of a maximal strictly decreasing sequence of subcontinua recursively created in the following way: take all points of non local connectedness of the previous continuum and consider the irreducible continuum containing all of them. This degree cannot increase while taking continuous transformation, and thanks to it, it was possible to construct, in [3], arbitrary large finite families of dendroids that are incomparable by continuous transformations,[8] and later, in [183], an uncountable family of continua homeomorphic to their hyperspaces of subcontinua.

An arcwise connected space X is *uniformly arcwise connected* if for every $\varepsilon > 0$ there is a positive integer k such that each arc in X can be divided into k subarcs of diameter less then ε. This notion was generalized 10 years later by Włodzimierz Kuperberg to *uniform pathwise connectedness*, and such continua were characterized as continuous images of the Cantor fan.[9] For uniquely arcwise connected continua, in particular for dendroids, arcwise and pathwise uniform connectedness are equivalent.

A dendroid (a continuum) X is *smooth at* $p \in X$ if for every sequence of points x_n converging to x the arcs (continua) px_n converge to px. One of the main results of [10] is the proof that the

[8] It is still not known if such uncountable families exist. From translator: Recently, Piotr Minc has constructed such an uncountable family.

[9] A fan is a dendroid with only one ramification point.

Cantor fan is universal[10] in the class of smooth fans. Smooth dendroids were then considered the simplest ones, but even they may have very surprisingly interesting properties. The cylinder of the Cantor step function onto an arc is a dendroid that has the set of its ramification points[11] being homeomorphic to an interval. In [2], an example of a smooth dendroid is constructed that is homeomorphic to the set of its ramification points, and in [53] a smooth dendroid is constructed that has only ramification points and end points.

A *confluent mapping* is probably the most important notion introduced into topology by JJC. It is a mapping $f : X \to Y$ between compact spaces such that each component of the preimage $f^{-1}(K)$ of an arbitrary continuum $K \subset Y$ is mapped onto the whole K. Open mappings and monotone ones between compact spaces are confluent. In [4], JJC proved that a confluent image of a dendroid is a dendroid and of a λ-dendroid is a λ-dendroid; later, in 1972, T. B. McLean showed that a confluent image of a tree-like continuum is a tree-like continuum. Investigation of properties of confluent mappings, their numerous generalizations and variations, has been done by many Polish and American topologists. In the latter part of the article, we will see that those mappings are very important in continuum theory.

1.2. Monotone decompositions and the fixed point property

One of the most important classical results in continuum theory is Kuratowski's theorem on the existence of minimal monotone upper semi continuous decomposition of an irreducible continuum onto an arc. In other words, there is a continuous monotone function of such continuum X onto an interval I such that layers of any continuous monotone map of X onto I are unions of layers

[10] A space X belonging to some class of spaces is *universal* in the class if every space from the class can be embedded in X; universal smooth dendroids were constructed by J. Grispolakis and E. D. Tymchatyn in 1978, by W. J. Charatonik in 1984, and by L. Kohler and J. Nickel in 1986.

[11] A point $x \in X$ is a ramification point if it is a common end point of at least three arcs in X that are disjoint out of x; x is an end point in X if it is an end point of every arc in X that contains the point x; x is an ordinary point if it is neither an end point nor a ramification point.

of the mapping f. In articles [9] and [17], JJC showed the existence of such minimal decompositions for λ-dendroids and later for arbitrary continua; the decomposition spaces are dendroids (for arbitrary continua, they are hereditarily arcwise connected). He has also constructed a λ-dendroid that has only one layer [8].

It was known that dendroids have the fixed point property for continuous transformations, and thus, a natural question arrived in the Knaster seminar if λ-dendroids have the property, too. JJC applied the minimal decompositions to obtain some theorems about fixed points, for example, for λ-dendroids not containing one-layer subcontinua or for monotone mappings, as well as for some multivalued functions. He commented on the results, "Even if I did not obtain the final results in the area by myself, introducing this subject turned out to be fruitful and successful: Roman Mańka proved the fixed point property for continuum-valued functions of a λ-dendroid into itself."[12]

Papers [6], [7], [8], [9], and [11] on the decompositions and fixed points formed JJC's habilitation dissertation.

1.3. Planarity, contractibility, selectibility, and means

In 1959, Knaster posed a problem of characterizing (using internal, structural conditions) plane dendroids. JJC devoted several of his papers to the investigation of the subject of planarity of continua, in particular of dendroids. The problem is hard and still open. Results worth mentioning show that there is no countable family of dendroids determining nonplanarity of smooth dendroids [27]. (It is known that there are four curves such that a locally connected curve is not planar if and only if it contains a copy of one of them.[13]) Moreover, planar dendroids must have ordinary points [87].

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[12] Mańka published his theorem in Fundamenta Mathematicae in 1974. This theorem was the main result of his Ph.D. dissertation, which he started under the supervision of JJC. (The final supervisor was Knaster.) The fixed point property for λ-dendroids is now recognized as one of the most important achievements of the Knaster seminar.

[13] Two Kuratowski graphs and two Kuratowski curves; Claytor Theorem, 1937.

A space is *contractible* if there is a homotopy joining identity with a constant mapping. Dendroids appear naturally in investigating contractibility: it is easy to observe that contractible curves must be dendroids, but it is an open and hard problem of an internal characterization of contractible dendroids. JJC discovered some obstacles of contractibility; those are, among others, non uniform arcwise connectedness [16], or containing a specially approximated arc, called an R-arc, in the dendroid [31]. The notion of smoothness was also useful in the research, namely smoothness implies contractibility, even hereditary contractibility (i.e., each subcontinuum is contractible) of dendroids [31].

The problems of contractibility of dendroids were investigated by JJC's students and by many topologists in the USA. There are many modifications and interesting new notions that extend the list of obstacles of contractibility (see review articles [94], [116]).[14]

Another property of dendroids is their *selectibility*; i.e., the existence of a mapping $f : C(X) \to X$ defined on the hyperspace of subcontinua of a continuum X (with the Hausdorff metric) and assigning a point $s(A) \in A$ for every $A \in C(X)$. A continuum is called *selectible* if such selection exists. In 1970, it was observed by Sam B. Nadler, Jr., and L. E. Ward, Jr., that each selectible continuum is a dendroid. We can also consider a selection on the hyperspace 2^X of closed subsets of X, but then X must be an arc.[15] Because $C(X)$ is a continuous image of the Cantor fan, it is easy to see that each selectible dendroid is uniformly arcwise connected.

Which dendroids are selectible? What are the connections between selectibility and contractibility? These non trivial and not finally answered questions were posed by JJC and have become inspirational for his students.

If we identify X with the subspace $F_1(X) \subset 2^X$ of the one-point subsets of X, then the selection s can be seen as a special retraction from $C(X)$ or 2^X onto X. This leads to investigation of continua that are retracts of their hyperspaces. And again we are led to dendroids: if X is a curve that is a retract of $C(X)$ or 2^X, then it

[14] Recently W. J. Charatonik has solved an old problem of characterization of hereditarily contractible continua as pointwise smooth dendroids, a variation of smoothness defined by S. T. Czuba.

[15] K. Kuratowski, S. B. Nadler, Jr., and G. S. Young, 1970.

is a uniformly arcwise connected dendroid.[16] We can also consider retractions from some subspaces of 2^X; for example, if there is a retraction $\mu : F_2(X) \to F_1(X) = X$, where $F_2(X)$ denotes the space of at most 2-point sets, then μ is called a 2-argument mean on X (equivalently, a 2-argument mean is a continuous operation on X that is symmetric and idempotent). JJC devoted much of his time investigating means on continua, in particular on dendroids, starting in the early 1990s ([100], [105], [134], [136], [210]). He inspired some coauthors on this subject. In [156], it was shown, among other things that smooth plane dendroids admit means, but there are smooth dendroids that do not [134].

Problems of contractibility, selectibility, and existence of means interested JJC for the rest of his life. He was interested in similar, but slightly different phenomena that appeared as obstacles for the properties. He was trying to discover their common core and interrelations (see an excellent article [216]). In many papers, he investigated if those properties are preserved by some special mappings (monotone, open, confluent).

1.4. Dendrites

JJC devoted much of his work to dendrites. The constructions worth mentioning include strongly chaotic dendrites (i.e., such that no open subset is homeomorphic to any other open subset), that are also strongly rigid (i.e., the only homeomorphism into itself is the identity) [119], as well as chaotic and rigid with respect to open mappings, monotone and related ones [161]. These kinds of peculiar continua are still being discovered and have interesting applications.

In an extensive dissertation [111], JJC and co-authors Włodzimierz J. Charatonik and Janusz R. Prajs investigate the quasi order relation in the class of dendrites defined by the existence of a continuous surjective map from some class $\mathcal{M}$ of mappings (for example, open, monotone, etc.) between dendrites. In recent years, there has been interest in relations of this kind in various classes of continua (including dendrites) and their complexity in the sense of descriptive set theory.[17] This trend in investigation that joins methods of the two theories seems to be very promising.

[16] J. T. Goodykoontz, Jr., 1985.

[17] R. Camerlo, U. Darji, A. Marcone, C. Rosendal.

In [237], dendrites were characterized as the only continua X having the lifting property relative to confluent 0-dimensional mappings for arbitrary continuum Y: for every confluent 0-dimensional map $f : Y \to f(Y)$ and for every map $g : X \to f(Y)$, if x and y satisfy $g(x) = f(y)$, then there is a map $\tilde{g} : X \to Y$ such that $g = f \circ \tilde{g}$ and $\tilde{g}(x) = y$.

1.5. Generalized homogeneity

A space is homogeneous with respect to a class $\mathcal{M}$ of continuous transformations if for every $x, y \in X$ there is a surjection $f : X \to X$ such that $f \in \mathcal{M}$ and $f(x) = y$. If $\mathcal{M}$ is the class of homeomorphisms, then we get a classical definition of a homogeneous space. Homogeneous continua are some of the most interesting objects that continuum theory deals with from the beginning. The idea of investigating continua homogeneous with respect to some other classes of continua was attributed by JJC to David P. Bellamy, but in the literature, the notion of generalized homogeneity appeared for the first time in 1978 in [29] and [30]. One of the first results was a neat characterization of the pseudo-arc that showed the possibility of generalizing classical theorems on homogeneity: the pseudo-arc is the only chainable[18] continuum that is openly homogeneous [29]. In [52], it was shown that the Sierpiński universal plane curve is homogeneous with respect to monotone mappings, and in [96], [121], and [128], monotone homogeneity of universal dendrites with different kinds of ramification points is investigated.

We must mention a fundamental work with Tadeusz Maćkowiak [65], in which the authors have obtained some generalizations of the Effros Theorem about actions of a group of autohomeomorphisms of a compact space X to actions of Borel subgroups, the semigroup of open mappings as well as Borel subsets of the space of autosurjections. They later had essential applications to investigations of homogeneity with respect to open or confluent mappings, analogously as the Effros Theorem was applied to investigate homogeneous continua.

JJC promoted generalized homogeneity in many of his review articles, problems, and conference talks, leading to many interesting

[18] A continuum is chainable if it is an inverse limit of arcs.

and deep results.[19] It is still an open question, posed by JJC, if the pseudo-circle (i.e., hereditarily indecomposable [20] plane continuum that is an inverse limit of circles with essential bonding mappings) is openly homogeneous.

1.6. Absolute retracts in some classes of continua

Continuum Y is an absolute retract in a class $\mathcal{C}$ of continua ($Y \in AR(\mathcal{C})$) if embedded in an arbitrary continuum $X \in \mathcal{C}$ is a retract of X. If $\mathcal{C}$ is the class of metric continua, then we get the classical notion of an absolute retract. For narrower classes of continua there were known, thanks to Bellamy and Maćkowiak, only a few examples of absolute retracts: the pseudo-arc in the class of hereditarily indecomposable continua, the simplest Knaster indecomposable continuum,[21] and cones over 0-dimensional compact sets in the class $\mathcal{HU}$ of hereditarily unicoherent continua.

In a series of articles [189], [197], [198] , [218], [233], [234], [243], [244], [245], and [247] written in collaboration with W. J. Charatonik and Prajs, much progress was made in investigating absolute retracts in some classes of continua, for example, tree-like continua and $\mathcal{HU}$. The authors developed new techniques, introducing the notion of the arc property of Kelley,[22] and confluently tree-like continua,[23] and discovering a new meaning of confluent mappings.

[19]Among others, Prajs proved in 1998 that the disc is openly homogeneous and that Sierpiński carpet manifolds (for the Sierpiński carpet itself independently, C. R. Seaquist, 1999) are homogeneous with respect to mappings that are open and monotone; in 1989, he characterized solenoids as continua that are openly homogeneous and have arcs only as proper subcontinua.

[20]Each subcontinuum is indecomposable.

[21]That is an inverse limit of intervals with bonding mappings $f(t) = \begin{cases} 2t, & 0 \le t \le \frac{1}{2} \\ 2t-2, & \frac{1}{2} \le t \le 1 \end{cases}.$

[22]A continuum X has *the property of Kelley* if for every $p \in X$, for every subcontinuum $K \subset X$ containing p, and for every sequence $p_n \in X$ converging to p, there is a sequence of subcontinua $K_n \subset X$ containing the points p_n and converging to K; if the continua K_n are additionally arcwise connected, we call the property arc property of Kelley.

[23]A continuum is confluently tree-like if for every $\varepsilon > 0$ there is a confluent ε-mapping (i.e., having point preimages of diameter less than ε) from X onto a tree.

Among other things, it is shown that

- if for every $\varepsilon > 0$ there is a confluent ε-mapping from a continuum X onto a continuum with the arc property of Kelley (in particular onto a locally connected continuum), then X also has the arc property of Kelley;
- inverse limits of trees with confluent bonding mappings are in $AR(\mathcal{HU})$;
- elements of $AR(\mathcal{HU})$ have the arc property of Kelley and have ε-push property; that is, for every $\varepsilon > 0$ there is $\delta > 0$ such that for every $x, y \in X$ that satisfy $\rho(x, y) < \delta$, there is a continuous transformation $f : X \to X$ satisfying $f(x) = y$ and for arbitrary $p \in X$, we have $\rho(p, f(p)) < \varepsilon$;
- each $X \in AR(\mathcal{HU})$ without simple triods is chainable and every one of its proper subcontinua is an arc;
- if X is a dendroid, then $X \in AR(\mathcal{HU})$ if and only if X is homeomorphic to a retract of the Mohler-Nikiel universal smooth dendroid;
- each absolute retract for the class of tree-like continua, as well as each confluently tree-like continuum, is an approximative absolute retract (AAR);[24] as a consequence, such continua have the fixed point property, an important fact in investigating the question which tree-like continua have the fixed point property.

An important question asks if each absolute retract in the class $\mathcal{HU}$ (without simple triods) must be tree-like (an inverse limit of arcs with open bonding mappings).

1.7. Other research

One study worth mentioning is the one done in general topology in cooperation with Italian mathematicians that is connected with the real function theory.

The roots of [91] are in the so-called Mazurkiewicz metric (the distance between points is measured as the greatest lower bound of diameters of continua containing those points). Let C be the family of arcwise connected subsets of a topological space (X, τ). Take the family of arc components of sets open in τ as a base of

[24] $X \in AAR$ if embedded in any compact space X', for every $\varepsilon > 0$ there is $f : X' \to X$ such that $\rho(x, f(x)) < \varepsilon$ for all $x \in X$.

a new, larger topology τ_C. Then the equivalence holds: (X, τ) is arcwise connected if and only if (X, τ_C) is connected.

In [175], conditions concerning the openness of real functions on topological spaces are investigated. It is shown that for metrizable locally compact spaces, the openness of a function at a point is equivalent to the non-existence of a local extremum at that point if and only if the domain is connected im kleinen at that point.

In [91], it is shown that the set of continuous real functions on a complete space X that have dense sets of local maxima and local minima is residual in the space $C(X, \mathbb{R})$ of continuous functions with the topology of uniform convergence. In [86], the residuality and density in $C(X, Y)$ is shown of the set of continuous functions having nowhere dense layers if X is metrizable (or separable and $T_{3\frac{1}{2}}$) without isolated points and Y is a normed space.

JJC wrote many articles in collaboration with Mexican mathematicians (Alejandro Illanes, Sergio Macías, Isabel Puga, Gerardo Acosta, Patricia Pellicer-Covarrubias, Raúl Escobedo, Héctor Méndez-Lango). Some of them deal with his favorite subjects (like dendrites or dendroids); others are inspired by the hyperspace theory that Mexico is famous for. One of their specialities in hyperspace theory is investigating the hyperspace $C_n(X) \subset 2^X$ of nonempty closed subsets of X that have at most n components. Induced mapping on hyperspaces[25] makes for an important subject. In [203], many facts that were known for induced maps between hyperspaces $C(X)$ were generalized for mappings between $C_n(X)$. Not all of them are obvious and not all facts that are true for $n = 1$ are true for $n > 1$. For example, if $f : X \to Y$ is a "very nice" transformation; i.e., if it is the composition of a monotone and an open map, then the induced map is also of this kind for $n \leq 2$, but not for $n > 2$. In the earlier work [141], other connections between mappings and their induced mappings were discovered.

An interesting and perhaps surprising result JJC obtained collaborating with his son Włodzimierz in [172] is the fact that there

[25]If $f : X \to Y$, then $\hat{f}$ defined on respective hyperspaces by $\hat{f}(A) = f(A)$ is called a map induced by f.

is no Whitney map[26] defined on 2^X or $F_2(X)$ if X is a non-metric continuum.

One of the last papers JJC wrote with Włodzimierz is [255], in which they construct a continuum X with the property of Kelley such that the hyperspace $C(X)$ and the product $X \times [0, 1]$ do not have that property. It is a counterexample answering a famous question by Nadler (1978) and Hisao Kato (1991).

2. Reviews

JJC wrote review papers, many of them of exceptional value. Among the most important ones are two historical articles ([127], [135]) and one encyclopedic article ([231]). Concerning specialized topics, it seems it would be hard to find better papers on acyclic curves than [94], [116], and [140]. The still up-to-date articles containing open problems ([126], [176], [216]) are also recommended.

3. Students and Colleagues

A major part of a scientist's success may be measured by his students, and it is impossible to define how many mathematicians consider JJC as their teacher. Generations of students have attended his seminars and lectures in Wrocław, Opole, and Mexico City. One will find some well-known names on the list of his 11 Ph.D. students. Some of them have already promoted doctoral students of their own. I do not remember the first person on the list; he returned to his country immediately after obtaining the degree. Tadeusz Maćkowiak, one of the most talented students, is no longer with us; he died prematurely in 1986. Some currently work abroad: Zbigniew Piotrowski, Youngstown State University, USA; Jacek Nikiel, American University of Beirut, Lebanon; Janusz R. Prajs, California State University, Sacramento, USA; Verónica Martínez de la Vega, UNAM. Stanisław Miklos has recently retired. Krzysztof Omiljanowski and I are still at the Mathematical Institute, University of Wrocław. Zbigniew Rakowski and Stalisław T. Czuba no longer work in the field of topology. Tae Jin Lee from

[26] A continuous function $\mu : (2^X, \subset) \to [0, \infty)$ that is strictly increasing and has value zero at singletons is called a Whitney map. Whitney maps are basic tools in the theory of hyperspaces of metric continua.

North Korea was forced to leave Poland at the time he had finished his thesis; he is said to have obtained the degree in Korea. Panayotis Spyrou traveled from Athens to Wrocław many times to write his dissertation under JJC's supervision, although JJC was not his formal advisor. The thesis was defended at the University in Athens.

One of JJC's traits was the ability to ask questions, often in the form of interesting research programs, which were a great source of motivation for his students. He was always careful not to omit any results, encouraging his coauthors and students to write down their findings. Whenever they faced trouble with doing so, or simply took too much time, JJC would do the work for them. Owing to his persistence, many works were published. He had an ease of writing and found it enjoyable: thanks to his mentor Knaster, JJC picked up the skill of scrupulous editing of texts. Every paper had to be reader-friendly; thus, uncommon abbreviations were avoided, while appropriate examples illustrating the validity of the hypotheses, discussions on inverse theorems, open questions, and an extensive bibliography were always present.

JJC enjoyed collaboration and had a strong ability to work with others. He had 26 coauthors from 7 countries: U.S.A, Poland, Italy, Greece, North Korea, Mexico, and the Czech Republic. Most of the time he worked with his son Włodzimierz, completing more than 60 common papers. Among the people whom he worked with most intensively are Stanisław Miklos, Krzysztof Omiljnowski, Janusz Prajs, and Alejandro Illanes.

PH.D. STUDENTS ADVISED BY JJC

(1) Bassam N. Nashif (Iraq), 1973: *Multi-valued functions, coincidences and fixed points.*
(2) Tadeusz Maćkowiak, 1974: *Continuous functions on continua.*
(3) Zbigniew M. Rakowski, 1976: *On decompositions of continua.*
(4) Zbigniew Piotrowski, 1979: *A study of certain classes of almost continuous functions on topological spaces.*
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(8) Stanisław Miklos, 1986: *Mappings of connected spaces.*
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(10) Janusz J. Prajs, 1990: *On homogeneous continua in Euclidean spaces.*
(11) Verónica Martínez de la Vega y Manilla (Mexico), 2002: *Studies of dendroids and compactifications.*

PH.D. DISSERTATIONS WRITTEN UNDER JJC'S SUPERVISION

(1) Panayotis Spyrou (Athens), 1981-1986: *Aposyndesis and depth of a continuum.*
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