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SIMPLICITY OF CATEGORIES DEFINED BY SYMMETRY AXIOMS

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ABSTRACT. We consider two generalizations R_{0_W} and R_0 of the usual symmetry axiom for topological spaces to arbitrary closure spaces and convergence spaces. It is known that the two properties coincide on Top and define a non-simple subcategory. We show that R_{0_W} defines a simple subcategory of closure spaces and R_0 a non-simple one. The last negative result follows from the stronger statement that every epireflective subcategory of R_0 Conv containing all T_1 regular topological spaces is not simple. Similar theorems are shown for the topological categories Fil and Mer.

A full and isomorphism closed epireflective subcategory **L** of a topological category **H** is called simple if there exists a single object $E \in |\mathbf{L}|$ such that **L** is the epireflective hull of $\{E\}$ in **H**. This also means that every object of **L** is a subobject of a power of E.

In this context "Y is a subobject of X" means that there exists an embedding from Y to X, so that Y is an extremal subobject in the categorical sense. For further details on these notions we refer to [9].

Simplicity problems for TOP and its subcategories defined by means of separation axioms T_0, T_1, T_2 and by the symmetry axiom R_0 have been settled for quite some time [6], [7], [15]. Pretop is known to be simple. Simplicity of its subcategories defined by T_0, T_1, T_2 properties has recently been studied by the authors in [13].

In the first section of this paper we show that while R_{0_W} and R_0 both are extensions of the same symmetry axiom in TOP, they define subcategories of Pretop, where R_{0_W} Pretop is simple and R_0 Pretop is not. The negative result for R_0 Pretop is a consequence of a generalization of a well known result of Herrlich [7].

In the second section we generalize this result yet one step further to R_0 convergence spaces. As a consequence we can conclude that every epireflective subcategory of R_0 Conv containing all T_1 regular topological spaces is not simple.

In the last section we consider epireflective subcategories of the categories Fil of filter spaces and Mer of merotopic spaces. Our main theorem in this section states that every epireflective subcategory of Fil (of Mer) containing all spaces that are both T_1 regular filterspaces and $c^\wedge$ embedded Cauchy spaces, is not simple in Fil (in Mer).

1. **Closure spaces.**

For topological spaces it is well known that the following properties are equivalent ($\dot{x}$ denotes the filter generated by $\{x\}$ and $\mathcal{W}(x)$ is the neighborhoodfilter in x).

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(i) $\dot{x} > \mathcal{W}(y) \Rightarrow \mathcal{W}(x) = \mathcal{W}(y)$
(ii) $\dot{x} > \mathcal{W}(y) \Rightarrow \dot{y} > \mathcal{W}(x)$

Each of them defines the usual R_0 axiom for topological spaces. Spaces satisfying this axiom are also called symmetric topological spaces. It was shown in [8] that the R_0 topological spaces are exactly those embeddable into merotopic spaces.

For closure spaces with a non-idempotent closure operator, conditions (i) and (ii) are not longer equivalent. Condition (i) was used in [16] as a definition of R_0 closure spaces and it was shown that R_0 closure spaces are exactly those embeddable into merotopic spaces. Condition (ii) defines a weaker property which we will denote by R_{0_w}. Both R_0 and R_{0_w} are extensions of the topological R_0 axiom.

Let R_0 Pretop and R_{0_w} Pretop be the full subcategories of Pretop defined by the properties R_0 and R_{0_w} respectively. Both R_0 Pretop and R_{0_w} Pretop are bireflective subcategories of Pretop.

It is known (see e.g. [15]) that R_0 Top is not simple in TOP. We will show that the two different extensions of the R_0 property to Pretop give different answers with regard to simplicity in Pretop.

THEOREM 1.1. *R_{0_w} Pretop is simple.*

PROOF. On $X = \{0,1,2\}$ we define a closure structure by means of the neighborhoodfilters of its points in the following way: $\mathcal{W}(0) = \{X\}, \mathcal{W}(1) = \langle\{0,1\}\rangle, \mathcal{W}(2) = \langle\{0,2\}\rangle$.

Clearly X has the R_{0_w} property. Moreover, if Y is any closure space having the R_{0_w}-property we define the following maps.

For $y \in Y$ and for any $U \in \mathcal{W}(y)$ let

$$f_{y,U}(z) = \begin{cases} 1 & \text{if } y = z \\ 0 & \text{if } z \in U \setminus \{y\} \\ 2 & \text{if } z \in Y \setminus U \end{cases}$$

It is easily checked that these functions are continuous. Moreover the source $(f_{y,U} : Y \longrightarrow X)_{y \in Y, U \in \mathcal{W}(y)}$ is point separating and Y has the initial Pretop-structure.

It follows that Y belongs to the epireflective hull of X. ∎

Next we consider the stronger symmetry axion R_0. In order to investigate the simplicity of R_0 Pretop we need the following notions.

DEFINITION 1.2. If Y is any closure space the relation

$$y_1 \sim y_2 \Leftrightarrow \mathcal{W}(y_1) = \mathcal{W}(y_2)$$

is an equivalence relation.

A map f: $X \longrightarrow Y$ between two closure spaces is quasiconstant if $f(x_1) \sim f(x_2)$ whenever $x_1, x_2 \in X$.

If $\phi\colon Y \longrightarrow Y|_{\sim}$ is the canonical surjection associated with the equivalence relation then clearly $f\colon X \longrightarrow Y$ is quasiconstant if and only if $\phi \circ f$ is constant. When Y is an R_0 closure space we have

$$\mathcal{W}(y_1) = \mathcal{W}(y_2) \Leftrightarrow \mathrm{cl}\{y_1\} = \mathrm{cl}\{y_2\}$$

and the equivalence classes of the relation above are exactly the closures of singletons of Y. Moreover in the case of an R_0 space non-equivalent points can be separated in a T_1 way i.e. each of them has a neighborhood not containing the other point. However, contrary to the topological case the Pretop-quotient $Y|_{\sim}$ of an R_0 closure space Y need not be T_1, as follows from the next example.

EXAMPLE 1.3. $Y = \{0\} \cup \{\frac{1}{n} | n \geqq 1\}$ *and a closure structure on* Y *is defined by the neighborhoods*

$$\mathcal{W}(0) = \left\langle \left\{ \{0\} \cup \left\{ \frac{1}{n} \middle| n \geqq m \right\} \middle| m \geqq 1 \right\} \right\rangle$$
$$\mathcal{W}\left(\frac{1}{n}\right) = \langle Y \setminus \{0\} \rangle \quad n \geqq 1$$

Clearly Y *is an* R_0 *space. However the Pretop quotient is the Sierpinski space and hence it is not* T_1.

The fact that the R_0 property alone is not sufficient to guarantee that the quotient is T_1 also follows from the next result.

PROPOSITION 1.4. *If* Y *is a closure space and* $Y|_{\sim}$ *is the Pretop quotient of the identification of Definition 1.2, then* $Y|_{\sim}$ *is a* T_1 *space if and only if both of the following conditions are fulfilled:*

(a) Y *is an* R_0 *space*

(b) $\mathrm{cl}\{y\}$ is closed whenever $y \in Y$.

PROOF. Suppose $Y|_{\sim}$ has the T_1 property and $\dot{y} > \mathcal{W}(z)$, y and $z \in Y$. If y and z are not equivalent then there exists $W \in \mathcal{W}(z)$ such that $\phi(y) \notin \phi(W)$ and of course this is impossible. So (a) clearly is fulfilled.

In order to prove (b) suppose $z \in \mathrm{cl}\,\mathrm{cl}\{y\}$. Since Y is R_0 the set $\mathrm{cl}\{y\}$ is exactly the y-equivalence class. Therefore $\phi(y) \in \phi(W)$ whenever $W \in \mathcal{W}(z)$. In view of the T_1 property of $Y|_{\sim}$ we can conclude that $\phi(z) = \phi(y)$ and then $z \in \mathrm{cl}\{y\}$.

Next suppose Y satisfies conditions (a) and (b) and $\phi(y) \neq \phi(z)$ then $z \notin \mathrm{cl}\{y\}$. Moreover since $\mathrm{cl}\{y\}$ is closed there exists a neighborhood W of z such that $\mathrm{cl}\{y\} \cap W = \emptyset$. Since Y is R_0 the set $\mathrm{cl}\{y\}$ is exactly the equivalence class of y. Therefore $\phi(W)$ is a neighborhood of $\phi(z)$ not containing y. The same way a neighborhood of $\phi(y)$ not containing $\phi(z)$ can be constructed. ∎

In [7] Herrlich has shown that a topological space Y is T_1 if and only if there exists a T_1 regular topological space X with at least two points such that every continuous function from X to Y is constant.

Our purpose is to find a generalization of this theorem for R_0 closure spaces. In spite of the fact that by Proposition 1.4 a generalization cannot be obtained by straightforward application of Herrlich's result to the identification $Y|_\sim$ of the given R_0 closure space Y, the proof in [7] can be modified in order to get the generalized result for the R_0-case.

THEOREM 1.5. *If Y is a closure space then the following are equivalent*

(a) Y is an R_0 space
(b) there is a regular T_1 topological space X (containing at least two points) such that every continuous map from X to Y is quasiconstant.

PROOF.
(b) $\Rightarrow$ (a). If Y is not an R_0 space then there exist y and y' in Y such that $\dot{y} > \mathcal{W}(y')$ and $\mathcal{W}(y) \neq \mathcal{W}(y')$. Let X be any regular T_1 topological space with at least two points and B an open non-empty and proper subset of X then the function $f\colon X \longrightarrow Y$ mapping B to y and $X|B$ to y' is continuous and not quasiconstant.

(a) $\Rightarrow$ (b). The same construction as the one applied by Herllich in [7] works here. We use the same notations and we will only indicate the modifications that have to be made.

1. Let Y be an R_0 closure space and suppose card $Y \leqq \aleph_\alpha$. For $i = 1, 2$ we put R_i a set of cardinality $\aleph_{\alpha+i}$, r_i a fixed point of R_i. We endow R_i with the same topology as in [7]: a subset B of R_i is open if $r_i \in B$ implies card$(R_i \setminus B) < \aleph_{\alpha+i}$.

Now if $f\colon R_i \longrightarrow Y$ is continuous and $f(r_i) = y_0$ then $f^{-1}(Y \setminus \{y\})$ is a neighborhood of r_i whenever $y_0 \notin \text{cl}\{y\}$. But then $\cap\{f^{-1}(Y \setminus \{y\}) | \, y_0 \notin \text{cl}\{y\}\}$ is a neighborhood too. Moreover using the R_0 property of Y we have

$$\begin{aligned}\cap\{f^{-1}(Y \setminus \{y\}) | \, y_0 \notin \text{cl}\{y\}\} &= \cap\{f^{-1}(Y \setminus \{y\}) | \, y \notin \text{cl}\{y_0\}\} \\ &= f^{-1}(\text{cl}\{y_0\})\end{aligned}$$

and $\text{cl}\{y_0\}$ is exactly the equivalence class of y_0. Hence f is quasiconstant on this neighborhood of r_i.

2. All constructions towards the final construction of X have to be repeated exactly as in [7]. Whenever it is shown in [7] that two points have equal images through a continuous function, the corresponding result will now be that the images are equivalent. As in [7] a sequence $X_0 \subset X_1 \subset X_2 \subset \cdots$ of regular T_1 topological spaces is constructed and whenever f is a continuous function from X_{n+1} to Y we now have that it is quasiconstant on X_n. On $X = \cup\{X_n | n = 0, 1, \ldots\}$ one takes the final topological structure for the sink $(j_n : X_n \longrightarrow X)_{n=0,1,\ldots}$ where j_n is the canonical injection of X_n to X. Then X is regular T_1 and when f is any continuous function from X to the given closure space Y the compositions $f \circ j_n$ are all continuous. Therefore f is quasiconstant on X. ∎

COROLLARY 1.6. *Every epireflective subcategory* **L** *of Pretop such that T_1 reg Top $\subset$* **L** *$\subset R_0$ Pretop is not simple.*

PROOF. Let Y be any space in $|\mathbf{L}|$ then if X is the space as constructed in the previous theorem, all continuous maps from X to Y are quasiconstant. But then, since X is a T_1 space, it cannot be initial for any source

$$(x \xrightarrow{f_i} Y)_{i\in I}. \qquad \blacksquare$$

2. Convergence spaces

In this section we consider convergence spaces in the sense of Fisher [4]. A strong symmetry axiom for convergence spaces was introduced in [16] in the following way.

DEFINITION 2.1. A convergence space is R_0 if

$$\dot{x} \longrightarrow y \Rightarrow x \text{ and } y \text{ have the same convergent filters.}$$

For closure spaces this definition coincides with the R_0 property defined in the previous section.

R_0 convergence spaces are exactly those embeddable in the category of merotopic spaces. The category R_0 Conv of R_0 convergence spaces is bireflective in Conv. For convergence spaces we use the equivalence relation as introduced in *Definition 1.2*: y_1 and y_2 in Y are equivalent ($y_1 \sim y_2$) if y_1 and y_2 have the same convergent filters.

Moreover, as before, a map $f : X \longrightarrow Y$ between two convergence spaces is called quasiconstant if $f(x_1) \sim f(x_2)$ whenever $x_1, x_2 \in X$.

Whenever Y is a convergence space let ψY be its Pretop reflection. The neighborhoodfilters of ψY are given by

$$\mathcal{W}(y) = \cap\{\mathcal{F} \mid \mathcal{F} \xrightarrow{Y} y\} = \cap\{\mathcal{U} \mid \mathcal{U} \text{ ultra, } \mathcal{U} \xrightarrow{Y} y\}.$$

PROPOSITION 2.2. *Let Y be an R_0 convergence space. Then the following properties hold*

(a) ψY is R_0

(b) $\mathcal{W}(y_1) = \mathcal{W}(y_2) \Leftrightarrow y_1$ and y_2 have the same Y-convergent filters.

PROOF.

(a) If $\dot{x} > \mathcal{W}(y)$ then $\dot{x} > \{\mathcal{U} \mid \mathcal{U} \text{ ultra, } \mathcal{U} \xrightarrow{Y} y\}$. It follows that in the collection of ultrafilters on the right there is one member containing $\{x\}$. Hence $\dot{x} \xrightarrow{Y} y$. Since Y is R_0 the points x and y have the same Y-convergent filters and then $\mathcal{W}(x) = \mathcal{W}(y)$.

(b) Suppose $\mathcal{W}(y_1) = \mathcal{W}(y_2)$. Since $\dot{y}_1 > \mathcal{W}(y_2)$ we can conclude as in (a) that $\dot{y}_1 \xrightarrow{Y} y_2$ and since Y is an R_0 space this again implies that y_1 and y_2 have the same convergent filters. Since the other implication is trivial, we are done. ■

Using this result we now can derive the following generalization of Theorem 1.5.

THEOREM 2.3. *If Y is a convergence space then the following are equivalent*

(a) Y is an R_0 space
(b) there is a regular T_1 topological space X (containing at least two points) such that every continuous map from X to Y is quasiconstant.

PROOF.
(a) $\Rightarrow$ (b) goes exactly as in the proof of Theorem 1.5.
(b) $\Rightarrow$ (a). Suppose Y is an R_0 convergence space. From Proposition 2.2 we know that ψY is an R_0 closure space. Then we can apply Theorem 1.5 to construct the T_1 regular topological space X. If $f : X \longrightarrow Y$ is continuous then $f : X \longrightarrow \psi Y$ is continuous and hence quasiconstant to ψY. Moreover since by Proposition 2.2 (b) the equivalence classes for Y and ψY are the same, f is quasiconstant to Y. ∎

COROLLARY 2.4. *Every epireflective subcategory* **L** *of Conv such that*

$$T_1 \text{ Reg Top } \subset \mathbf{L} \subset R_0 \text{ Conv}$$

is not simple.

The result of Theorem 2.3 should be compared with the next one which was obtained by R. Lowen together with the first author in [14].

THEOREM 2.5 [14]. *For every convergence space Y there exists a T_1 c-embedded convergence space X such that for any source $(f_i\colon X \longrightarrow Y)_{i\in I}$ the space X is not initial in* Conv.

For the definition of c-embedded spaces we refer to [3]. Note that Theorem 2.5 implies that every epireflective subcategory of Conv containing all T_1 c-embedded convergence spaces is not simple. In particular if R_{0_w} is the weak symmetry axiom for convergence spaces defined by

$$R_{0_w} : \dot{x} \longrightarrow y \Leftrightarrow \dot{y} \longrightarrow x$$

then it coincides with R_{0_w} for closure spaces and defines an epireflective subcategory R_{0_w} Conv. By the previous result R_{0_w} Conv is not simple.

REMARK 2.6. The space X constructed in Theorem 2.5 is T_1 and c-embedded. It is not a closure space and it does not satisfy the strong regularity condition in the sense of [8].

The space X used in Theorem 2.3 which was constructed by Herrlich in [7] is T_1 regular and topological. In general it is not an ω-regular space and so it is not necessarily c-embedded [11].

3. **Filterspaces and merotopic spaces**

Both Theorem 2.3 and Theorem 2.5 have immediate consequences with regard to simplicity of certain subcategories of the category Fil of all filter merotopic spaces.

For definitions and notations on Fil and its subcategories we refer to [1], [2], [9], [10] or [12]. We recall the following notations.

C is the full subcategory of Fil whose objects are those filter spaces X which satisfy: if $\mathcal{A}$ and $\mathcal{B}$ are micromeric in X and if for some point $x \in X$ we have $\mathcal{A} \longrightarrow x$ and $\mathcal{B} \longrightarrow x$ then $\{A \cup B \mid A \in \mathcal{A}, B \in \mathcal{B}\}$ is micromeric in X.

T_1 $\hat{c}$ emb Chy is the full subcategory of the category Chy of all Cauchy spaces whose objects are those T_1 Cauchy spaces X for which the source

$$X \xrightarrow{j} \mathrm{Hom}(\mathrm{Hom}(X, \mathbf{R}), \mathbf{R})$$

is initial.

T_1 Reg Fil is the full subcategory of Fil whose objects are the T_1 regular spaces in the sense of [8].

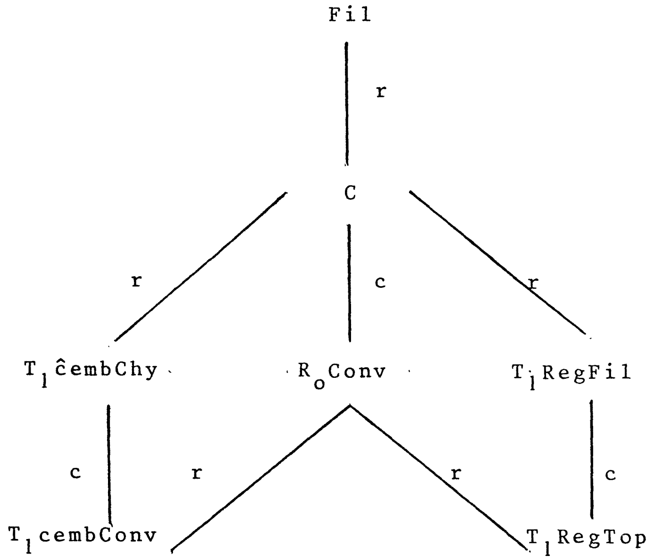
If we denote sub for the subspaces taken in the category Mer of merotopic spaces (or equivalently in Fil) we have [2], [12]

$\mathbf{C} = \text{sub } R_0 \text{ Conv}$

T_1 $\hat{c}$emb Chy = sub T_1 c emb Conv

T_1 Reg Fil = sub T_1 Reg Top.

Lines in the following diagram indicate subcategories, r stands for epireflective, c stands for coreflective. All coreflections are restrictions of the R_0 Conv coreflection of a **C**-space.



Theorems 2.3 and 2.5 now immediately imply that every epireflective subcategory **L** of Fil such that T_1 $\hat{c}$ emb Chy $\subset$ **L** $\subset$ Fil or T_1 Reg Fil $\subset$ **L** $\subset$ **C** is not simple.

This result can be considerably improved by means of the following result.

THEOREM 3.1. *For every filter space Y there exists a space X in*

$$|T_1 \text{ Reg Fil } \cap \ \hat{C} \text{ emb Chy}|$$

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such that for any source $(f_i\colon X \longrightarrow Y)_{i \in I}$ *the space X is not initial in* Fil.

PROOF. The proof is analogous to the proof of the main theorem in [14]. Let Y be an arbitrary filter space. Take an infinite set X with cardinality strictly larger than the cardinality of the underlying set of Y. Further we fix a uniform ultrafilter $\mathcal{U}$ on X. We make X a filterspace in the following way.

A filter $\mathcal{F}$ on X is micromeric if $\mathcal{F} = \dot{x}$ for some point $x \in X$ or $\mathcal{F}$ is a non principal ultrafilter different from $\mathcal{U}$. Clearly X is a T_1 Cauchy space. Let $\mathcal{F}$ be any micromeric filter on X. It is easy to calculate that with the notations of [8] we have $\mathcal{F}(<) = \mathcal{F}$. Hence X is regular in the sense of [8].

Every bounded real valued function is Cauchy continuous and μX is the discrete topology. Using the characterization theorem in [5] we can conclude that X is $c\hat{}$ embedded.

Now let $(f_i\colon X \longrightarrow Y)_{i \in I}$ be a source in Fil, then by the proposition in [14] for every $i \in I$ there exists an ultrafilter $\mathcal{W}_i \neq \mathcal{U}$ such that $\text{stack}_Y f_i(\mathcal{W}_i) = \text{stack}_Y f_i(\mathcal{U})$. Hence $\text{stack}_Y f_i(\mathcal{U})$ is micromeric for every $i \in I$. It follows that $\mathcal{U}$ is micromeric in the initial filter space of the source. So finally we can conclude that X cannot be initial in Fil. ■

At this point it is natural to ask whether an analogous improvement of Theorems 2.3 and 2.5 can also be obtained in the category of convergence spaces. This question is formulated in the following:

PROBLEM 3.2. Given any R_0 convergence space Y can one always construct a space $X \in |T_1 \text{ reg Top} \cap c \text{ emb Conv}|$ such that for any source $(f_i\colon X \longrightarrow Y)_{i \in I}$ the space X is not initial in Conv.

COROLLARY 3.3. *Every epireflective subcategory* **L** *of* Fil *such that* T_1 Reg Fil $\cap$ $c\hat{}$ emb Chy $\subset$ **L** *is not simple in* Fil.

The same construction can be used to formulate the corresponding result about non-simplicity in the category Mer of all merotopic spaces. The proof goes completely analogous to the proof of Theorem 3.1.

THEOREM 3.4. *For every merotopic space Y there exists a space X in* $|T_1$ Reg Fil $\cap$ $c\hat{}$emb Chy$|$ *such that for any source* $(f_i\colon X \longrightarrow Y)_{i \in I}$ *the space X is not initial in* Mer.

COROLLARY 3.5. *Every epireflective subcategory* **L** *of* Mer *such that* T_1 Reg Fil $\cap$ $c\hat{}$ emb Chy $\subset$ **L** *is not simple in Mer.*

REFERENCES

1. H. L. Bentley, H. Herrlich and W. A. Robertson, *Convenient Categories for topologists*, Comment. Math. Univ. Carol. **17**(1976), 207–227.

2. H. L. Bentley, H. Herrlich and E. Lowen-Colebunders, *Convergence*, J. Pure and App. Alg. **65**(1990), 27–45.

3. E. Binz, *Continuous Convergence on C(X)*, Lect. Notes in Math. **469**, Springer-Verlag, Berlin, 1975.

4. H. R. Fisher, *Limesraüme*, Math. Ann. **137**(1959), 269–303.

5. R. Gazik and D. C. Kent, *Regular completions of Cauchy spaces via function algebras*, Bull. Austral. Math. Soc. **11**(1974), 77–88.
6. D. W. Hajek and A. Mysior, *On non-simplicity of topological categories*, Lect. Notes in Math. **719**(1979), 84–93.
7. H. Herrlich, *Wann sind alle stetigen Abbildungen in Y konstant?* Math. Zeitschr. **90**(1965), 152–154.
8. H. Herrlich, *Topological structures, in: Topological structures*, Math. Centre Tracts **52**, Amsterdam 1974, 59–122.
9. H. Herrlich, *Categorical topology 1971–1981, in: Proc. of the Fifth Prague Topological Symposium 1981*, Heldermann Verlag, Berlin, 1983, 279–383.
10. M. Katetov, *On continuity structures and spaces of mappings*, Comment. Math. Univ. Carol. **6**(1965), 257–278.
11. D. C. Kent, K. McKennon, G. Richardson and M. Schroder, *Continuous convergence in* $C(X)$, Pacific J. Math. **52**(1974), 271–279.
12. E. Lowen-Colebunders, *Function classes of Cauchy Continuous Maps, Pure and Applied Mathematics*, Marcel Dekker Inc., New York, 1989.
13. E. Lowen-Colebunders and Z. G. Szabo, *On the simplicity of some categories of closure spaces*, comment. Math. Univ. Carol. **31**(1990), 95–98.
14. E. Lowen and R. Lowen, *On the non-simplicity of some convergence categories*, Proc. Amer. Math. Soc., **105**(1989), 305–308.
15. T. Marny, *Rechts-Bikategoriestructuren in topologischen Kategorien*, Thesis, F.U. Berlin, 1973.
16. W. A. Robertson, *Convergence as a Nearness Concept*, Thesis, Carleton University, 1975.

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