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# Almost $v$-open mappings

**S. Balasubramanian[1], C. Sandhya[2] and P. Aruna Swathi Vyjayanthi[3]**

*[1]Department of Mathematics, Government Arts College (A), Karur – 639 005, T.N., India*

*[2]Department of Mathematics, C.S.R. Sarma College, Ongole – 523 001, A.P., India*

*[3]Research Scholar, Dravidian University, Kuppam – 517 425, A.P., India*
*E-mail: mani55682@rediffmail.com*

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*ABSTRACT*

*The aim of the paper is to study basic properties of v-open mappings and interrelations with other mappings.*

***Keywords:*** $v$-open sets, $v$-continuity, $v$-irresolute, $v$-open mappings and almost $v$-open mappings.

**Ams:** 54C10, 54C08, 54C05.

## 1. INTRODUCTION:

Mappings plays an important role in the study of modern mathematics, especially in Topology and Functional Analysis. Open mappings are one such mapping which are studied for different types of open sets by various mathematicians for the past many years. In this paper we tried to study a new variety of open maps called almost $v$-open maps. Throughout the paper X, Y means a topological spaces $(X, \tau)$ and $(Y, \sigma)$ unless otherwise mentioned without any separation axioms defined in it.

## 2. Preliminaries:

**Definition 2.1:** $A\subset X$ is called
(i) pre-open if $A\subseteq (cl\ A)^o$ and pre-closed if $cl\{(A^o)\} \subseteq A$;
(ii) semi-open if $A\subseteq cl\{(A^o)\}$ and semi-closed if $(cl\ A)^o\subseteq A$;
(iii)semipre-open[$\beta$-open] if $A\subseteq cl\{((cl\ A)^o)\}$ and semipre-closed[$\beta$-closed] if $(cl\{(A^o)\})^o\subseteq A$;
(iv) $\alpha$-open if $A\subseteq (cl\{(A^o)\})^o$ and $\alpha$-closed if $cl\{((cl\ A)^o)\}\subseteq A$;
(v) regular open if $A = (cl\ A)^o$ and regular closed if $A = cl\{(A^o)\}$
(vi) $v$-open if there exists a regular open set U such that $U\subseteq A\subseteq cl\ U$.
(vii)r$\alpha$-closed if there exists a regular closed set U such that $\alpha (U)o \subseteq A\subseteq U$.
(viii)g-closed[resp: rg-closed] if $cl\ A\subseteq U$ whenever $A\subseteq U$ and U is open[resp: regular open].

**Note 1:** From the above definition we have the following implication diagram.

$$\begin{array}{ccccc}
\text{al.r}\alpha\text{.open set} & \rightarrow & \textbf{al.}v\textbf{-open set} & & \\
\uparrow & & \downarrow & & \\
\text{al.r. open set} & \rightarrow & \text{al.s. open set} & \rightarrow & \text{al. }\beta\text{. open set} \\
\downarrow & & & & \\
\text{al.open set} & \rightarrow & \text{al. }\alpha\text{. open set} & & \\
\downarrow & & & & \\
\text{al.p. open set} & & & &
\end{array}$$

**Definition 2.2:** A function $f$: X→ Y is said to be

(1) continuous [resp:pre-continuous; semi-continuous; $\beta$-continuous; $\alpha$-continuous; nearly-continuous; $v$-continuous; r$\alpha$-continuous] if the inverse image of every open set is open[resp:pre-open; semi-open; $\beta$-open; $\alpha$-open; regular-open; $v$-open; r$\alpha$-open]

(2) irresolute [resp:pre-irresolute; β-irresolute; α-irresolute; nearly-irresolute; *v*-irresolute; rα-irresolute] if the inverse image of every semi-open[resp:pre-open; β-open; α-open; regular-open; *v*-open; rα-open] set is semi-open[resp:pre-open; β-open; α-open; regular-open; *v*-open; rα-open]

(3) open [resp:pre-open; semi-open; β-open; α-open; nearly-open; rα-open] if the image of every open set is open[resp:pre-open; semi-open; β-open; α-open; regular-open; rα-open]

(4) almost open[resp:almost pre-open; almost semi-open; almost β-open; almost α-open; almost nearly-open; almost rα-open] if the image of every regular open set is open[resp:pre-open; semi-open; β-open; α-open; regular-open; rα-open]

(5) g-continuous [resp:rg-continuous] if the inverse image of every open set is g-open[resp:rg-open]

**Definition 2.3:** X is said to be $T_{1/2}$[r-$T_{1/2}$] if every [regular-] generalized closed set is [regular-]closed

### 3. Almost *v*-open mappings:

**Definition 3.1:** A function *f:* X→ Y is said to be almost *v*-open if image of every regular open set in X is *v*-open in Y

**Theorem 3.1:**
(i) Every almost-r-open map is almost *v*-open but not conversely.
(ii) Every almost-r-open map is almost rα-open but not conversely.
(iii)Every almost rα-open map is almost *v*-open but not conversely.
(iv) Every almost *v*-open map is almost semi-open but not conversely.
(v) Every almost *v*-open map is almost β-open but not conversely.
(vi) Every almost-r-open map is almost open but not conversely.
(vii)Every almost-r-open map is almost semi-open but not conversely.

**Proof:** (i) *f* is almost-r-open → image of every regular open set is r-open → image of every regular open set is *v*-open[since every r-open set is *v*-open] → *f* is almost *v*-open.

Similarly we can prove the remaining parts using definition 2.1 and Note 1.

**Example 1:** Let X = Y = {a, b, c}; τ = σ = {ϕ, {a}, {b}, {a, b}, X}. Let *f:* X→ Y is identity map. Then *f* is almost *v*-open.

**Example 2:** Let X = Y = {a, b, c}; τ = σ = {ϕ, {a}, {b}, {a, b}, X}. Let *f:* X→ Y be the map defined as *f* (a) = b; *f* (b) = c and *f*(c) = a is not almost *v*-open.

**Example 3:** Let X = Y = {a, b, c}; τ = {ϕ, {a}, {b, c}, X} and σ = {ϕ, {a}, {b}, {a, b}, X} and let *f:* X→ Y is identity map. Then *f* is almost *v*-open}, almost semi-open, almost β-open and almost rα-open but not almost-open, almost-r-open, almost-pre-open and almost α-open.

**Example 4:** Let X = Y = {a, b, c}; τ = {ϕ, {a}, {b, c}, X} and σ = {ϕ, {a, c}, X} and let *f:* X→ Y is identity map. Then *f* is almost β-open but not almost *v*-open}, almost semi-open, almost rα-open, almost-open, almost-r-open, almost-pre-open and almost α-open.

**Example 5:** Let X = Y = {a, b, c}; τ = {ϕ, {a}, {b, c}, X} and σ = {ϕ, {a, c}, X} and let *f:* X→ Y be the map defined as *f*(a) = c; *f*(b) = b and *f*(c) = a. Then *f* is almost β-open and almost-pre-open but not almost *v*-open}, almost semi-open, almost rα-open, almost-open, almost-r-open and almost α-open.

**Example 6:** Let X = Y = {a, b, c}; τ = {ϕ, {a}, {b, c}, X} and σ = {ϕ, {b}, {a, b}, {b, c}, X} and let *f:* X→ Y be the map defined as *f*(a) = b; *f*(b) = b and *f*(c) = c. Then *f* is almost α-open and almost-open but not almost *v*-open.

**Theorem 3.2:**
(i) If RαO(Y) = RO(Y), then *f* is almost rα-open iff *f* is almost-r-open.
(ii) If RαO(Y) = *v*O(Y), then *f* is almost rα-open iff *f* is almost *v*-open.
(iii) If *v*O(Y) = RO(Y), then *f* is almost-r-open iff *f* is almost *v*-open.
(iv) If *v*O(Y) = αO(Y), then *f* is almost α-open iff *f* is almost *v*-open.

**Corollary 3.1:**
(i) Every almost rα-open map is almost semi-open and hence almost β-open but not conversely

(ii)Every almost-r-open map is almost β-open but not conversely

**Note 2:**
(i) almost open map and almost *v*-open map are independent to each other
(ii) almost α-open map and almost *v*-open map are independent to each other
(iii) almost pre-open map and almost *v*-open map are independent to each other

**Example 6:** In Example 2 above, *f* is almost open; almost pre-open and almost α-open but not almost *v*-open.

**Example 7:** *f* as in Example 3 is almost *v*-open but not almost open; almost pre-open and almost α-open.

**Example 8:** *f* as in Example 6 is almost open; almost pre-open and almost α-open but not almost *v*-open.

**Example 9:** *f* as in Example 5 is almost β-open but not almost *v*-open

**Note 4:** We have the following implication diagram among the open maps.

$$\begin{tikzcd}
\text{al.r}\alpha\text{.o-map} \arrow[r] & \textbf{al.}v\textbf{.o-map} \arrow[d] & \\
\text{al.r.o-map} \arrow[u] \arrow[r] \arrow[d] & \text{al.s.o-map} \arrow[r] & \text{al. }\beta\text{.o-map} \\
\text{al.open map} \arrow[r] \arrow[d] & \text{al. }\alpha\text{.o-map} & \\
\text{al.p.o-map} & &
\end{tikzcd}$$

**Theorem 3.3:**
(i) If *f* is almost open and *g* is *v*-open then $g \bullet f$ is almost *v*-open
(ii) If *f* is almost open and *g* is r-open then $g \bullet f$ is almost *v*-open
(iii) If *f* and *g* are almost-r-open then $g \bullet f$ is almost *v*-open
(iv) If *f* is almost-r-open and *g* is almost *v*-open then $g \bullet f$ is almost *v*-open

**Proof:** (i) Let A be regular open set in X $\Rightarrow f(A)$ is open in Y $\Rightarrow g(f(A))$ is *v*-open in Z $\Rightarrow g \bullet f(A)$ is *v*-open in Z $\Rightarrow g \bullet f$ is almost *v*-open.

Similarly we can prove the remaining parts and so omitted.

**Corollary 3.2:**
(i) If *f* is almost open and *g* is almost *v*-open[almost-r-open] then $g \bullet f$ is almost semi-open and hence almost β-open

(ii) If *f* and *g* are almost-r-open then $g \bullet f$ is almost semi-open and hence almost β-open

(iii) If *f* is almost-r-open and *g* is almost *v*-open then $g \bullet f$ is almost semi-open and hence almost β-open

**Theorem 3.4:** If $f$: X→ Y is almost *v*-open, then $f(A^o) \subset v(f(A))^o$

**Proof:** Let A⊂ X be regular open and $f$: X→ Y is almost *v*-open gives $f(A^o)$ is *v*-open in Y and $f(A^o) \subset f(A)$ which in turn gives $v(f(A^o))^o \subset v(f(A))^o$ (1)

Since $f(A^o)$ is *v*-open in Y, $v(f(A^o))^o = f(A^o)$ (2)

combaining (1) and (2) we have $f(A^o) \subset v(f(A))^o$ for every subset A of X.

**Remark 1:** converse is not true in general.

**Corollary 3.3:** If $f$: X→ Y is almost-r-open, then $f(A^o) \subset v(f(A))^o$

**Theorem 3.5:** If $f$: X→ Y is almost *v*-open and A⊂ X is regular open, then $f(A)$ is $\tau_v$-open in Y.

**Proof:** Let A⊂ X be regular open and $f$: X→ Y is almost *v*-open implies $f(A^o) \subset v(f(A))^o$ which in turn implies $f(A) \subset v(f(A))^o$, since $f(A) = f(A^o)$. But $v(f(A))^o \subset f(A)$. Combining we get $f(A) = v(f(A))^o$. Therefore $f(A)$ is $\tau_v$-open in Y.

**Corollary 3.4:** If $f$: X→ Y is almost-r-open, then $f(A)$ is $\tau_v$-open in Y if A is r-open set in X.

**Theorem 3.6:** If $v(A)^o = r(A)^o$ for every $A\subset Y$, then the following are equivalent:
(i) $f: X\to Y$ is almost $v$-open map
(ii) $f(A^o)\subset v(f(A))^o$

**Proof:** (i)$\Rightarrow$ (ii) follows from theorem 3.4

(ii) $\Rightarrow$ (i) Let A be any regular open set in X, then $f(A) = f(A^o)\subset v(f(A))^o$ by hypothesis. We have $f(A) \subset v(f(A))^o$. Combining we get $f(A) = v(f(A))^o = r(f(A))^o$[ by given condition] which implies $f(A)$ is r-open and hence $v$-open. Thus $f$ is almost $v$-open.

**Theorem 3.7:** $f: X\to Y$ is almost $v$-open iff for each subset S of Y and each regular open set U containing $f^{-1}(S)$, there is a $v$-open set V of Y such that $S\subset V$ and $f^{-1}(V) \subset U$.

**Proof:** Assume $f$ is almost $v$-open, $S\subset Y$ and $U\in RO(X, f^{-1}(S))$, then $f(X - U) \in v\,O(Y)$ and $V = Y - f(X - U)$ is $v$-open in Y. $f^{-1}(S) \subset U$ implies $S\subset V$ and $f^{-1}(V) = X - f^{-1}(f(X - U)) \subset X - (X - U) = U$.

Conversely let F be a regular open in X, then $f^{-1}(f(F^c))\subset F^c$. By hypothesis, exists $V\in v\,O(Y)$ such that $f(F^c)\subset V$ and $f^{-1}(V) \subset F^c$ and so $f\subset (f^{-1}(V))^c$. Hence $V^c\subset f(F) \subset f[(f^{-1}(V))^c]\subset V^c$ implies $f(F) \subset V^c$, which implies $f(F) = V^c$. Thus $f(F)$ is $v$-open in Y and therefore $f$ is $v$-open.

**Remark 2:** composition of two almost $v$-open maps is not almost $v$-open in general

**Theorem 3.8:** Let X, Y, Z be topological spaces and every $v$-open set is r-open in Y, then the composition of two almost $v$-open maps is almost $v$-open.

**Proof:** Let A be regular open in X $\Rightarrow f(A)$ is $v$-open in Y $\Rightarrow f(A)$ is r-open in Y[by assumption] $\Rightarrow g(f(A))$ is $v$-open in Z $\Rightarrow g\bullet f(A)$ is $v$-open in Z $\Rightarrow g\bullet f$ is almost $v$-open.

**Theorem 3.9:** If $f: X\to Y$ is almost g-open; $g:Y\to Z$ is $v$-open[r-open] and Y is $T_{1/2}$[r-$T_{1/2}$], then $g\bullet f$ is almost $v$-open.

**Proof:**(i) Let A be regular open in X $\Rightarrow f(A)$ is g-open in Y $\Rightarrow f(A)$ is open in Y[since Y is $T_{1/2}$] $\Rightarrow g(f(A))$ is $v$-open in Z $\Rightarrow g\bullet f(A)$ is $v$-open in Z $\Rightarrow g\bullet f$ is almost $v$-open.

(ii) Since every g-open set is rg-open, this part follows from the above case.

**Corollary 3.5:** If $f: X\to Y$ is almost g-open; $g$: $Y\to Z$ is $v$-open[r-open] and Y is $T_{1/2}${r-$T_{1/2}$}, then $g\bullet f$ is almost semi-open and hence almost β-open.

**Corollary 3.6:** If $f: X\to Y$ is almost g-open; $g$: $Y\to Z$ is almost $v$-open[almost r-open] and Y is r-$T_{1/2}$, then $g\bullet f$ is almost semi-open and hence almost β-open.

**Proof:** Since every g-open set is rg-open, part follows from the above theorem.

**Theorem 3.10:** If $f: X\to Y$ is almost rg-open; $g$: $Y\to Z$ is $v$-open[r-open] and Y is r-$T_{1/2}$, then $g\bullet f$ is almost $v$-open.

**Proof:** Let A be regular open in X $\Rightarrow f(A)$ is rg-open in Y $\Rightarrow f(A)$ is r-open in Y[since Y is r-$T_{1/2}$] $\Rightarrow f(A)$ is open in Y[since every r-open set is open] $\Rightarrow g(f(A))$ is $v$-open in Z $\Rightarrow g\bullet f(A)$ is $v$-open in Z $\Rightarrow g\bullet f$ is almost $v$-open.

**Theorem 3.11:** If $f: X\to Y$ is almost rg-open; $g$: $Y\to Z$ is almost $v$-open[almost r-open] and Y is r-$T_{1/2}$, then $g\bullet f$ is almost $v$-open.

**Corollary 3.7:** If $f: X\to Y$ is almost rg-open; $g$: $Y\to Z$ is $v$-open[r-open] and Y is r-$T_{1/2}$, then $g\bullet f$ is almost semi-open and hence almost β-open.

**Corollary 3.8:** If $f: X\to Y$ is almost rg-open; $g$:$Y\to Z$ is almost $v$-open[almost r-open] and Y is r-$T_{1/2}$, then $g\bullet f$ is almost semi-open and hence almost β-open.

**Theorem 3.12:** If $f: X\to Y$; $g$: $Y\to Z$ be two mappings such that $g\bullet f$ is $v$-open[r-open]. Then the following are true
(i) If $f$ is continuous[r-continuous] and surjective, then $g$ is $v$-open
(ii) If $f$ is g-continuous, surjective and X is $T_{1/2}$, then $g$ is $v$-open
(iii)If $f$ is g-continuous[rg-continuous], surjective and X is r-$T_{1/2}$, then $g$ is $v$-open

**Proof:** (i) Let A be regular open in Y $\Rightarrow f^{-1}(A)$ is open in X $\Rightarrow g\bullet f(f^{-1}(A))$ is $v$-open in Z $\Rightarrow g(A)$ is $v$-open in Z $\Rightarrow g$ is almost $v$-open.

Similarly we can prove the remaining parts and so omitted.

**Corollary 3.9:** If $f$: X→ Y; $g$: Y→ Z be two mappings such that $g\bullet f$ is $v$-open[r-open]. Then the following are true
(i) If $f$ is continuous[r-continuous] and surjective, then $g$ is semi-open and hence β-open
(ii) If $f$ is g-continuous, surjective and X is $T_{1/2}$, then $g$ is semi-open and hence β-open
(iii)If $f$ is g-continuous[rg-continuous], surjective and X is r-$T_{1/2}$, then $g$ is semi-open and hence β-open

**Theorem 3.13:** If X is $v$-regular, $f$: X→ Y is r-closed, nearly-continuous, $v$-open surjection and $A^o = A$ for every $v$-open set in Y, then Y is $v$-regular.

**Proof:** Let $p\in U\in vO(Y)$, there exists a point $x\in X$ such that $f(x) = p$ by surjection. Since X is $v$-regular and $f$ is nearly-continuous exists $V\in RC(X)$ such that

$x\in V^o\subset V\subset f^{-1}(U)$ which implies $p\in f(V^o)\subset f(V) \subset U$ (1)

for $f$ is $v$-open, $f(V^o)\subset U$ is $v$-open. By hypothesis $f(V^o)^o = f(V^o)$ and $f(V^o)^o = \{f(V)\}^o$ (2)

combaining (1) and (2) $p\in f(V)^o\subset f(V) \subset U$ and $f(V)$ is r-closed. Hence Y is $v$-regular.

**Corollary 3.10:** If X is $v$-regular, $f$: X→ Y is r-open, nearly-continuous, $v$-open surjection and $A^o = A$ for every r-open set in Y, then Y is $v$-regular.

**Theorem 3.14:** If $f$: X→ Y is almost $v$-open[almost-r-open] and
(i) A is regular open set of X, then $f_A:(X, \tau_A) \to (Y, \sigma)$ is $v$-open.
(ii)X is $T_{1/2}$ and A is g-open set of X, then $f_A:(X, \tau_A) \to (Y, \sigma)$ is almost $v$-open.

**Proof:** Let F be r-open set in A. Then $f = A\cap E$ for some r-open set E of X and so F is r-open in X which implies $f(A)$ is $v$-open in Y. But $f(F) = f_A(F)$ and therefore $f_A$ is $v$-open.

**Corollary 3.11:** If $f$: X→ Y is almost $v$-open[almost-r-open] and
(i) A is regular open set of X, then $f_A:(X, \tau_A) \to (Y, \sigma)$ is semi-open and hence β-open.
(ii)X is $T_{1/2}$ and A is g-open set of X, then $f_A:(X, \tau_A) \to (Y, \sigma)$ is almost semi-open and hence almost β-open.

**Theorem 3.15:** If $f_i$: $X_i \to Y_i$ be almost $v$-open[almost-r-open] for i = 1, 2. Let $f$: $X_1\times X_2 \to Y_1\times Y_2$ be defined as follows: $f(x_1, x_2) = (f_1(x_1), f_2(x_2))$. Then $f$: $X_1\times X_2 \to Y_1\times Y_2$ is almost $v$-open.

**Proof:** Let $U_1\times U_2\subset X_1\times X_2$ where $U_i$ is regular open in $X_i$ for i = 1, 2. Then $f(U_1\times U_2) = f_1(U_1) \times f_2(U_2)$ a $v$-open set in $Y_1\times Y_2$. Thus $f(U_1\times U_2)$ is $v$-open and hence $f$ is almost $v$-open.

**Corollary 3.12:** If $f_i$: $X_i \to Y_i$ be $v$-open[r-open] for i = 1, 2. Let $f$: $X_1\times X_2 \to Y_1\times Y_2$ be defined as follows:
$f(x_1, x_2) = (f_1(x_1), f_2(x_2))$. Then $f$: $X_1\times X_2 \to Y_1\times Y_2$ is almost semi-open and hence almost β-open.

**Theorem 3.16:** Let $h$: $X \to X_1\times X_2$ be almost $v$-open[almost-r-open]. Let $f_i$: $X \to X_i$ be defined as $h(x) = (x_1, x_2)$ and $f_i(x) = x_i$. Then $f_i$: $X \to X_i$ is almost $v$-open for i = 1, 2.

**Corollary 3.13:** Let $h$: $X \to X_1\times X_2$ be almost $v$-open[almost-r-open]. Let $f_i$: $X \to X_i$ be defined as $h(x) = (x_1, x_2)$ and $f_i(x) = x_i$. Then $f_i$: $X \to X_i$ is almost semi-open and hence almost β-open for i = 1, 2.

**CONCLUSION:** We studied some properties and interrelations of almost $v$-open mappings.

**References:**

[1] Asit Kumar Sen and P. Bhattcharya, On preclosed mappings, Bull. Cal. Math. Soc., 85(1993), 409-412.

[2] S. Balasubramanian, C. Sandhya & P.A.S. Vyjayanthi, $v$-open sets and $v$-mappings, I.J.M.S.E.A., Vol.4 No. II (2010)395-405.

[3] S. Balasubramanian & P. A. S. Vyjayanthi, $v$-open mappings, Scientia Magna Vol 6. No. 4(2010) 118 - 124.

 

[4] S. Balasubramanian, C. Sandhya & P.A.S. Vyjayanthi, note on *v*-continuity, Bull. Kerala Math Association-Vol. 6, No.2, (2010 December) 21-28.

[5] S. Balasubramanian & P.A.S. Vyjayanthi, *v*-closed mappings, Jr. Advanced Research in Pure Mathematics, Vol 3. No. 1(2011)135 - 143.

[6] Di Maio. G., and Noiri.T, I. J. P. A. M., 18(3) (1987) 226-233.

[7] J. Dontchev, Mem.Fac.Sci.Kochi Univ.ser.A., Math., 16(1995), 35-48.

[8] W. Dunham, $T_{1/2}$ Spaces, Kyungpook Math. J.17(1977), 161-169.

[9] P. E. Long and L. L. Herington, Basic Properties of Regular Closed Functions, Rend. Cir. Mat. Palermo, 27(1978), 20-28.

[10] S. R. Malghan, Generalized closed maps, J. Karnatak Univ. Sci., 27(1982), 82 -88.

[11] A.S. Mashour, et.al., On pre-continuity and weak pre-continuity, Math. Phys. Soc. Egypt 53(1982), 47-53.

[12] A. S. Mashour, I.A.Hasanein and S.N.El.Deep, $\alpha$-continuous and $\alpha$-open mappings, Acta Math. Hungar., 41(1983), 213-218.

[13] T. Noiri, A generalization of closed mappings, Atti. Accad. Naz. Lincei Rend. Cl. Sci. Fis. Mat. Natur., 54 (1973), 412-415.

[14] T. Noiri, Almost $\alpha g$-closed functions and separation axioms, Actaq Math. Hungar. 82(3) (1999),193-205.

[15] N. Palaniappan, Studies on Regular-Generalized Closed Sets and Maps in Topological Spaces, Ph. D Thesis, Alagappa University, Karikudi, (1995).

[16] Shantha Bose., Semi open sets and semicontinuity, Bull.Cal.Math.Soc.,

[17] A. K. Sen and P.Bhattacharyya, On preclosed mappings, Bull. Cal. Math. Soc., 85(1993), 409-412.

[18] M. K. Singal and A. R. Singal, Almost continuous mappings, Yokohoma Math. J.13 (1973), 27-31.

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