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and Geometric  
Methods of Analysis**

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## LIST OF TOPICS

- Topological methods in analysis
- Geometric problems of complex and mathematical analysis
- Algebraic methods in geometry
- Differential geometry in the whole
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Geometric and topological methods in natural sciences

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# Commuting sets for topological set operators

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Let  $X$  be a set and  $F, G : 2^X \rightarrow 2^X$  be two set operators on  $X$ . We say that a set  $A \subset X$  is *commuting set* for the pair  $F, G$  if  $F(G(A)) = G(F(A))$ .

For a topological space  $X$  commuting sets for the pair of set operators  $Cl, Int$  were characterized by Levine [2] as symmetric differences of clopen sets with nowhere dense sets. Similarly, Staley [3] obtained a criterion for commuting sets for the pair  $Int, \partial$  (here  $\partial$  denotes the topological boundary operator).

In this work we consider the following six set operators on a topological space:  $Cl, Int, \partial, Ext$  (the exterior of a set),  $*$  and  $+$ :  $A^* = A \setminus IntA$ ,  $A^+ = ClA \setminus A$  (these two operators were explicitly defined and studied by Elez and Papaz [1]). It is possible to obtain characterizations of commuting sets for each pair of these six operators. As an application of these characterizations we present new criteria for the following well-known classes of topological spaces:

- *nodec*: a space in which every nowhere dense set is closed;
- *extremally disconnected*: a space in which the closure of every open set is also open;
- *strongly irresolvable*: a space in which each open subspace is *irresolvable* (i.e. it cannot be expressed as a disjoint union of two dense sets);
- *perfectly disconnected*: a  $T_0$ -space in which any pair of disjoint subsets have no common limit points.

**Theorem 1.** *Let  $B$  be a clopen set and  $C$  be a nowhere dense set. Then the symmetric difference  $B \Delta C$  is a commuting set for the pair  $Cl, *$  if and only if  $B \cap C$  is closed.*

**Corollary 2.** *A space is nodec if and only if any commuting set for the pair  $Cl, Int$  is also a commuting set for the pair  $Cl, *$ .*

**Proposition 3.** *Let  $X$  be a space. Then:*

- (1)  *$X$  is extremally disconnected if and only if any open set is a commuting set for the pair  $Cl, Int$ ;*
- (2)  *$X$  is strongly irresolvable if and only if any nowhere dense set is a commuting set for the pair  $Cl, Int$ .*

**Corollary 4.** *A space is extremally disconnected and strongly irresolvable if and only if any set is a commuting set for the pair  $Cl, Int$ .*

**Proposition 5.** *A space is perfectly disconnected if and only if any set is a commuting set for the pair  $Cl, *$ .*

## REFERENCES

- [1] N. Elez and O. Papaz. The new operators in topological space. *Math. Morav.*, 17(2): 63–68, 2013.
- [2] N. Levine. On the commutivity of the closure and interior operators in topological spaces. *Amer. Math. Monthly*, 68(5): 474–477, 1961.
- [3] D.H. Staley. On the commutativity of the boundary and interior operators in a topological space. *Ohio J. Sci.*, 68(2): 84, 1968.

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