



Krzysztof P. Rybakowski

The Homotopy Index and Partial Differential Equations

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The homotopy index theory was developed by Charles Conley for two-sided flows on compact spaces. The homotopy or Conley index, which provides an algebraic-topological measure of an isolated invariant set, is defined to be the homotopy type of the quotient space N/N_1 , where N is a certain compact pair, called an index pair. Roughly speaking, N_1 isolates the invariant set and N_2 is the "exit ramp" of N . It is shown that the index is independent of the choice of the index pair and is invariant under homotopic perturbations of the flow. Moreover, the homotopy index generalizes the Morse index of a non-degenerate critical point p with respect to a gradient flow on a compact manifold. In fact if the Morse index of p is k , then the homotopy index of the invariant set $\{p\}$ is I_k - the homotopy type of the pointed k -dimensional unit sphere.

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