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Topological vector spaces problems in homology and homotopy theories

We consider the topological vector spaces $\Omega^p(M)$, $\Omega_c^p(M)$, $\Omega_p^c(M)$, $\Omega_p(M)$, $p \geq 0$, of the de Rham cochains (C^∞-differential forms), of the de Rham cochains with compact supports (C^∞-differential forms with compact supports), of the de Rham chains with compact supports (currents with compact supports), of the de Rham chains (currents) of C^∞-manifold M, respectively. These spaces are Montel spaces and hence, reflexive. We show that they are hereditary reflexive (i.e., every closed subspace and every Hausdorff quotient is reflexive), because they are complete barreled nuclear spaces, whose strongly duals are complete and nuclear (in the sense of A. Grothendieck). We discuss a strong hereditary property (i.e., every closed subspace and every Hausdorff quotient is hereditary reflexive).

For compact manifold M these spaces determine $\mathbb{R}$-homotopy type of M. We discuss a nontrivial problem whether they determine $\mathbb{R}$-homotopy type and $\mathbb{R}$-proper homotopy type of non-compact M. We also discuss the problem of co-algebra structure on $\Omega_p^c(M)$, $\Omega_p(M)$ and their homologies.

We get the following two formulae in Geometric Integration Theory

$$\lim_{V_\alpha \to L^k} \frac{\int_{V_\alpha} \omega^m}{v_\alpha} = \int_{L^k} \omega^k$$

$$\lim_{V_\alpha \to L^k} \frac{\int_{V_\alpha} f(x_1, \dots, x_n)\, ds}{v_\alpha} = \frac{1}{\ell} \int_{L^k} f(x_1, \dots, x_n)\, d\ell$$

where M^n is a compact oriented n-dimensional manifold, S^m and L^k are its m- and k-dimensional compact oriented submanifolds with $0 \leq k < m \leq n$ and $L^k \subset S^m$, ω^m is any C^∞-differential m-form o S^m, ω^k is a unique C^∞-differential k-form on L^k, which depends only on ω^m, V_α is an arbitrary open neighborhood of L^k in S^m, v_α is an m-volume of V_α, $f(x_1, \dots, x_n)$ is a continuous function on S^m and ℓ is a k-volume of L^k.

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