

International
Scientific Conference



Algebraic
and Geometric
Methods
of Analysis

27-30 May 2024
Odesa, Ukraine

The purpose of this conference is to bring together researchers in geometry, topology, algebra, analysis and dynamical systems and to provide for them a forum to present their recent work to colleagues from different nationalities. This way we aim to stimulate discussion about the latest findings in geometrical and topological methods in analysis and to increase international collaboration.

The conference continues the traditional annual conference «Geometry in Odesa» holding from 2004, and hosted by Odesa National University of Technology (Odesa National Academy of Food Technologies till 2021). From 2017 the conference was renamed to «Algebraic and geometric methods of analysis» (AGMA).

The Conference languages: Ukrainian and English.

LIST OF TOPICS

- Algebraic methods in geometry
- Differential geometry in the large
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Dynamical systems and their applications
- Geometric and topological methods in natural sciences
- Geometric problems in mathematical analysis

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Dynamics of influenza with the rates of vaccination and treatment

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Influenza is one of the most common diseases worldwide. In this work, we investigate the dynamics of influenza effected by vaccination and treatment with an SIR model that includes Caputo type fractional derivative. These dynamics are explained with this model by using Fractional Backward Euler Method [1].

Remark 1. This is a joint work with Elif Demir. This work is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) Grant No: BIDEB2210A and Yildiz Technical University Scientific Research Projects Coordination Department with Project Number FYL-2023-5925.

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Topology of the Hilbert Schemes of monomial plane curve singularities

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Let X be a singular irreducible plane curve over \mathbb{C} . For a singular point o of X , we refer to the pair (X, o) as a plane curve singularity. Let $\mathcal{O}_{X,o}$ (resp. Γ) be the local ring of (X, o) (resp. the semi-group associated with (X, o)). We denote by $\text{Hilb}^r(X, o)$ the punctual Hilbert scheme of degree r for a given singularity (X, o) . Piontkowski [1] studied the topology of the Jacobian factor $J_{X,o}$ for a plane curve singularity (X, o) with $\Gamma = \langle p, q \rangle$ ($\gcd(p, q) = 1$). He showed the existence of an affine cell decomposition of the Jacobi factor $J_{X,o}$ and the Euler number of J_X and the Betti numbers of J_X are described. In this talk, we generalize Piontkowski's results to the cases of the punctual Hilbert schemes of (X, o) .

In this talk, we always consider the plane curve singularity whose local ring $\mathcal{O}_{X,o}$ is $\mathbb{C}[[t^p, t^q]]$ where $\gcd(p, q) = 1$. Then such a singularity has $\Gamma = \langle p, q \rangle$ as its semi-group. Let $\text{Mod}(\Gamma)$ be the set of all Γ -semi-modules. Defining $\text{codim}\Delta := \#(S \setminus \Delta)$, we set $\text{Mod}^r(\Gamma) := \{\Delta \in \text{Mod}(\Gamma) \mid \text{codim}\Delta = r\}$.

It is known that the components of $\text{Hilb}^r(X, o)$ is parametrized by the elements of $\text{Mod}^r(\Gamma)$.

$$\text{Hilb}^r(X, o) = \bigcup_{\Delta \in \text{Mod}^r(\Gamma)} H(\Delta) \tag{1}$$

The component $H(\Delta)$ in (1) is called the Δ -subset of $\text{Hilb}^r(X, o)$.

Theorem 1. *Let (X, o) be a plane curve singularity whose local ring $\mathcal{O}_{X,o}$ is $\mathbb{C}[[t^p, t^q]]$ where $\text{gcd}(p, q) = 1$. Each Δ -subset $H(\Delta)$ in (1) is isomorphic to an affine space whose dimension is given by*

$$\sum_{i=1}^{p-1} \#\{(\Gamma - \min \Delta) \cap [a_i, a_i + q]\} \setminus \Delta^{(0)}. \tag{2}$$

Here $\Delta^{(0)}$ is the 0-normalization of Δ and $\{a_0, \dots, a_{p-1}\}$ is the p -basis of $\Delta^{(0)}$.

The following fact follows from Theorem 1

Corollary 2. *Let (X, o) be a plane curve singularity with $\mathcal{O}_{X,o} = \mathbb{C}[[t^p, t^q]]$ ($\text{gcd}(p, q) = 1$). The Euler number of $\text{Hilb}^r(X, o)$ is equal to $\#\text{Mod}^r(\Gamma)$.*

We denote by $e(\text{Hilb}^r(X, o))$ the Euler number of $\text{Hilb}^r(X, o)$.

Example 3. The Euler numbers of the punctual Hilbert schemes for the A_{2l} -singularity are given in the following table:

r	$0 \leq r \leq 2l$	$r \geq 2l + 1$
$e(\text{Hilb}^r(X, o))$	$[r/2] + 1$	$l + 1$

Here the notation $[a]$ ($a \in \mathbb{R}$) is the biggest integer that is smaller than a .

Setting $\text{codim } H(\Delta) := \dim \text{Hilb}^r(X, o) - \dim H(\Delta)$, we define

$$\begin{aligned} \mathcal{H}_{r,d} &:= \{H(\Delta) \mid \Delta \in \text{Mod}^r(\Gamma) \text{ and } \dim H(\Delta) = d\}, \\ \mathcal{H}_r^d &:= \{H(\Delta) \mid \Delta \in \text{Mod}^r(\Gamma) \text{ and } \text{codim } H(\Delta) = d\}. \end{aligned}$$

Theorem 4. *Let (X, o) be a plane curve singularity with the local ring $\mathbb{C}[[t^p, t^q]]$ ($\text{gcd}(p, q) = 1$). Then the odd (co-) homology groups of $\text{Hilb}^r(X, o)$ are zero. The even (co-) homology groups of $\text{Hilb}^r(X, o)$ are free abelian groups with Betti numbers*

$$h_{2d}(\text{Hilb}^r(X, o)) = \#\mathcal{H}_{r,d} \text{ and } h^{2d}(\text{Hilb}^r(X, o)) = \#\mathcal{H}_r^d.$$

Example 5. The even (co-) homology groups of $\text{Hilb}^r(X, o)$ for the A_{2l} -singularity are given in the following table:

r	$0 \leq r \leq 2l$	$r \geq 2l + 1$
d	$0 \leq d \leq r$	$0 \leq d \leq l$
$h_{2d}(\text{Hilb}^r(X, o))$	1	1
$h^{2d}(\text{Hilb}^r(X, o))$	1	1

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