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Research statement

In my list of publications, you can find my publications enumerated.

Earlier research in view of publications

In my PhD,I did research on complex differential equations in the unit disc, on the growth of the solutions, and whether the solutions belong to certain function spaces.

In A1, I studied the exponential growth of solutions of ODEs in the case, where the coefficients have a singularity on the boundary of the unit disc. I developed a localization mapping from the unit disc to a drop-shaped adjustable subdomain, which meets the point of singularity. Via the localization mapping, some earlier results could be recovered from the general theory.

In A2, we found the sharp condition for the analytics solutions of f''+A(z)f=0 to be bounded or to belong to the Bloch space. We developed two general methods for the nth order equation and discussed the use of these methods also in the complex plane.

In A5, we studied when the analytic solutions of f''+A(z)f=0 belong to some function spaces such as the Bloch space or BMOA. We also studied when the solutions are bounded.

In A2, we used the methods of A5 to study when solutions of differential equations belong to a weighted Fock space of the complex plane.

In addition to my PhD, I have done research on univalent analytic and harmonic functions.

In A4, we studied analytic locally univalent functions in the unit disc via Becker's univalence criterion with a linear error. We found that the condition implies the function to be univalent in certain horodisk whose size depends on the coefficient in the error. We considered many related matters such as the distribution of the preimages of the attained values of the functions.

In A6, we studied harmonic locally univalent functions in the unit disc via Becker's univalence criterion and Nehari univalence criterion. We found conditions when the functions have bounded valence.

I have also collaborated with photonics researchers. My main contribution has been to assist with complex analytical and mathematical tools. My colleague Henri A. Pesonen uses Fourier modal method to study coherence properties of fields and pulses. We have had several mathematical discussions during the past years. As the titles suggest, A1 discusses *Partial spectral and temporal coherence of plane-wave pulse trains in second-harmonic generation* and A3 discusses *Spatial coherence effects in second-harmonic generation of scalar light fields.*

Recent research

During my postdoctoral research, I have done research on K. Yamanoi's methods in studying Zeros of higher derivatives of meromorphic functions in the complex plane. Yamanoi has obtained an asymptotic version of the Second main theorem of Nevanlinna theory. One inequality is based on detailed analysis of Jensen's formula - the analysis involves estimations of integrals, Borel type lemmas and many calculations. The other inequality is based on e.g. Ahlfors theory, and thin-thick-decomposition of the related hyperbolic

surface. Currently, I am a second supervisor for one doctoral student on the difference analogues of these considerations.

In 2019, I personally went to Japan to discuss with K. Yamanoi. I have a 2500€ travel grant to visit Japan again for one month – but I have postponed my trip due to COVID and current projects.

Related to my teaching, I have done research on visualizations of mathematics on browsers. Especially, I have studied the JSXGraph Javascript library and creating 3D visualizations there. Currently, my approach is being implemented in the JSXGraph core. I have also experimented on creating visualizations of planar mappings via Javascript. I have presented these approaches in two conferences and got enthusiastic feedback.

Future prospect

I will continue working on Yamanoi's method to study the meromorphic functions. Related to this, I will be the second supervisor of one PhD thesis. There are many difference analogues yet to be discovered. Also, there are some fundamental concepts in difference equations to be discussed. My coauthor of A6 has published the analogue of the Schwarzian derivative for harmonic locally univalent functions – this often reminds me that also in the fundamental concepts there is something to work on.

I have a method to visualize planar mappings via Javascript. It is based on an existing library which has been used for general purposes. Once the mathematical functionalities are made stronger, the visualizations ought to be very appealing.

Now, my visualizations have reached the level to be experimented in teaching. There should be some pedagogical studies on whether the visualizations help students to learn, and on how is their experience.