Physics of String and Homotopy Algebra

Yuji Ando / 安藤 雄史

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String Theory



String Theory=Elementary particle is not point particle but string. The modes of vibrations of the strings provide all the necessary ingredients to describe experimental results.

key word: Riemann surface and A_{∞} algebra

String and Riemann surface



String sweeps Riemann surface.

n-strings interacting picture is represented as *n*-punctured Riemann surface.

Moduli

interactions.

- Three-punctured Riemann surface There exists isomorphism between every the Riemann surface. Re Re $\simeq - \times \times - \times$ Four-punctured Riemann surface $\xrightarrow{\text{Re}} \not\simeq \xrightarrow{} \xrightarrow{}$ Re (Four-string scattering amplitude) = $\int_{-\infty}^{\infty} dm$ Re We have already known just results but want to know fundamental
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Moduli in string picture



If $I \cup I' = (-\infty, \infty)$ holds, there is no four-string interaction. If it does not hold, we introduce a four-string interaction.

Multi-linear map notation



Associativity and continuity



If m_2 has an associativity, $I \cup I'$ is continuous.

Yuji Ando

A_∞ algebra

Multilinear maps $\{m_n\}_{n\geq 1}$ are called an A_{∞} algebra when they satisfy the following relations: (J. D. Stasheff '63)

$$\begin{split} m_1(m_1(A)) &= 0 \\ m_1(m_2(A,B)) &= m_2(m_1(A),B) + (-1)^{|A|} m_2(A,m_1(B)) \\ m_1(m_3(A,B,C)) &= m_3(m_1(A),B,C) + (-1)^{|A|} m_3(A,m_1(B),C) \\ &+ (-1)^{|A|+|B|} m_3(A,B,m_1(C)) \\ &+ m_2(m_2(A,B),C) - m_2(A,m_2(B,C)) \end{split}$$

My research aims to understand the string theory through the use of such algebra.

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Recently topics

Recently, I have been working on things like this as well...

- Applied to study of Quantum Computer By using gravity, time translation scale in quantum system is able to be controlled. \Rightarrow arXiv:2410.02235[quant-ph]
- Black Hole from the perspective of information theory BH has entoropy which is physical quantity. Under study together with information theory researchers in a private company. \Rightarrow in progress

I look forward to working with you in the future!!