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Analytic continuation in the K-matrix formalism

with symbolic computation using the ComPWA framework
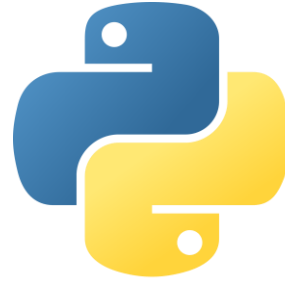
March 25th, 2024   K-matrix Day   **Lena Zeynep Pöpping**
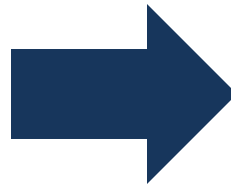
Symbolic computations

Python

array-oriented programming

Computer algebra system

Computational backends

Benefits:

- Nice user experience

- Self-documenting and transparent workflow

```
import sympy as sp

s, m0, g0 = sp.symbols("s m0 g0")
expression = g0**2 / (m0**2 - s)
expression
```

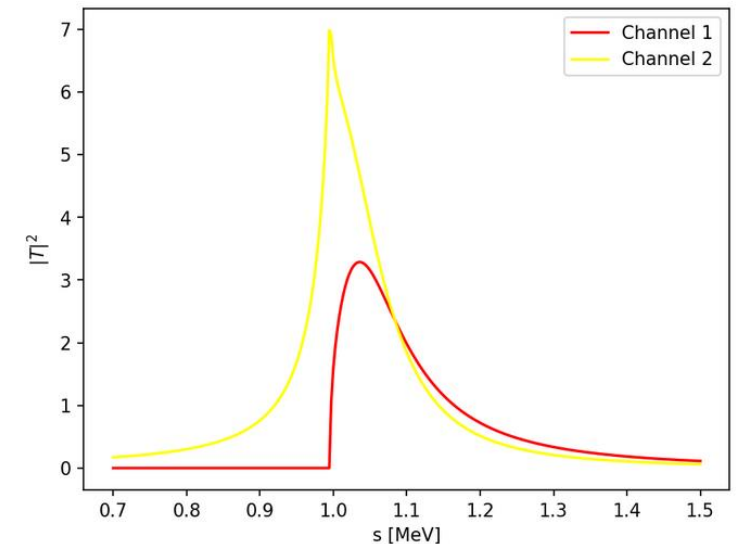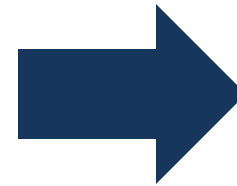$$\frac{g_0^2}{m_0^2 - s}$$

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Complex expansion

- Observables are real quantities

- Particle physics: Experimental data only for real values of s

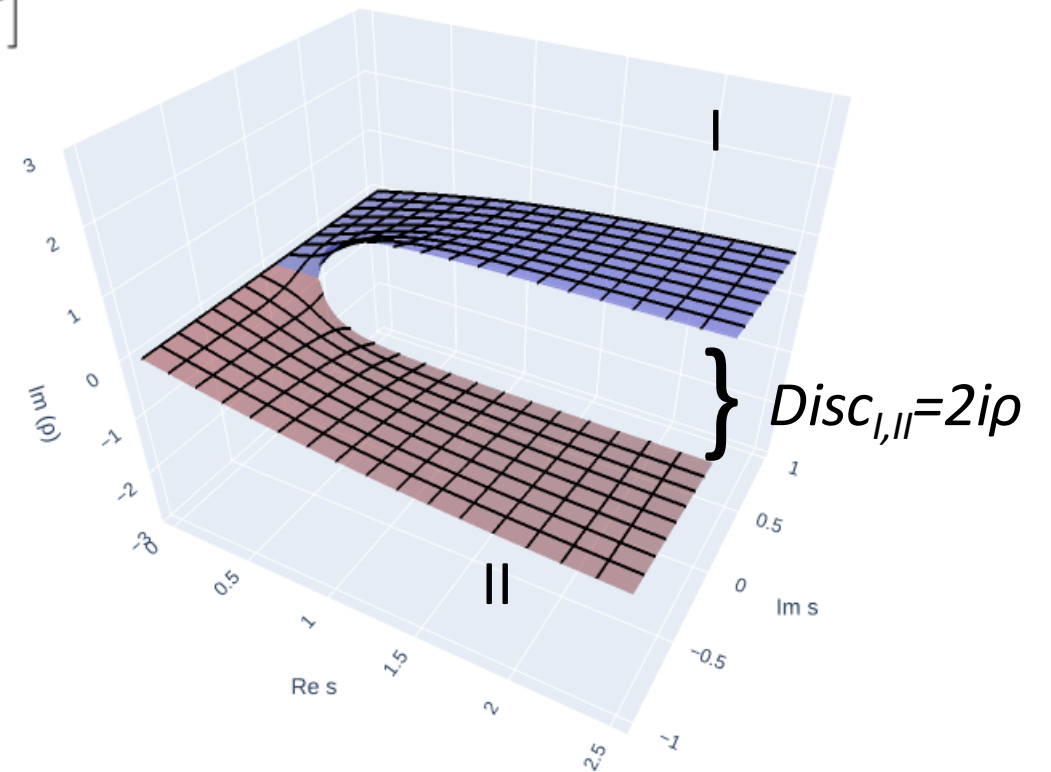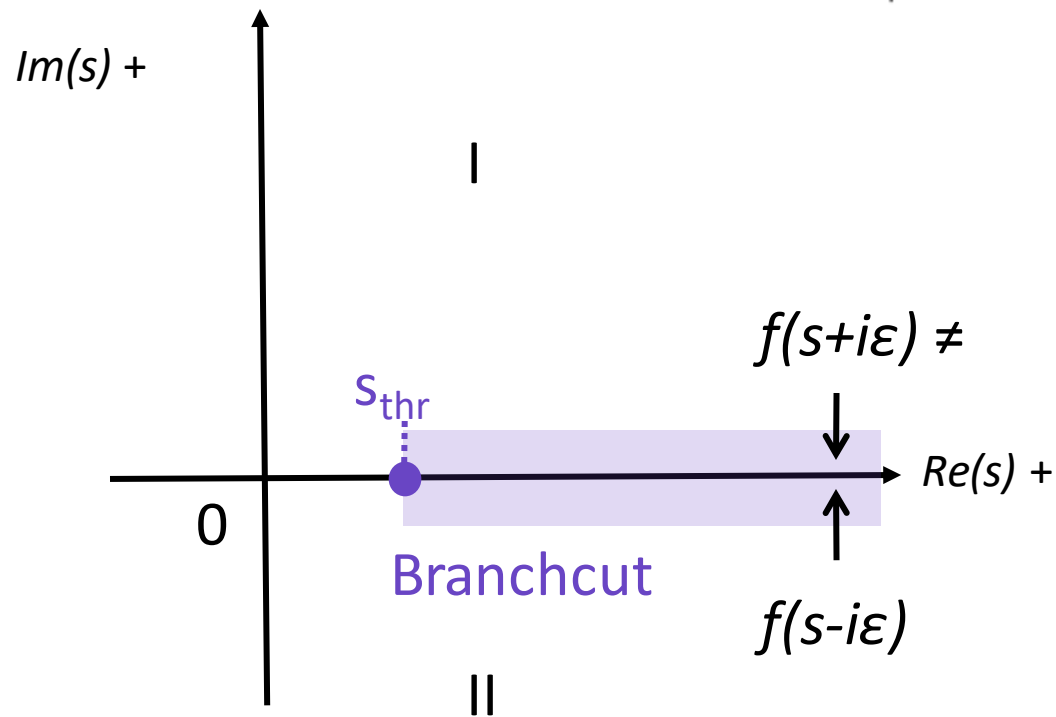Lineshape to describe dynamical part
of amplitude

- **Problem:** Desired particle properties can not be extracted directly only using the information on the real plane

- **Idea:** Expand dynamics function to complex s

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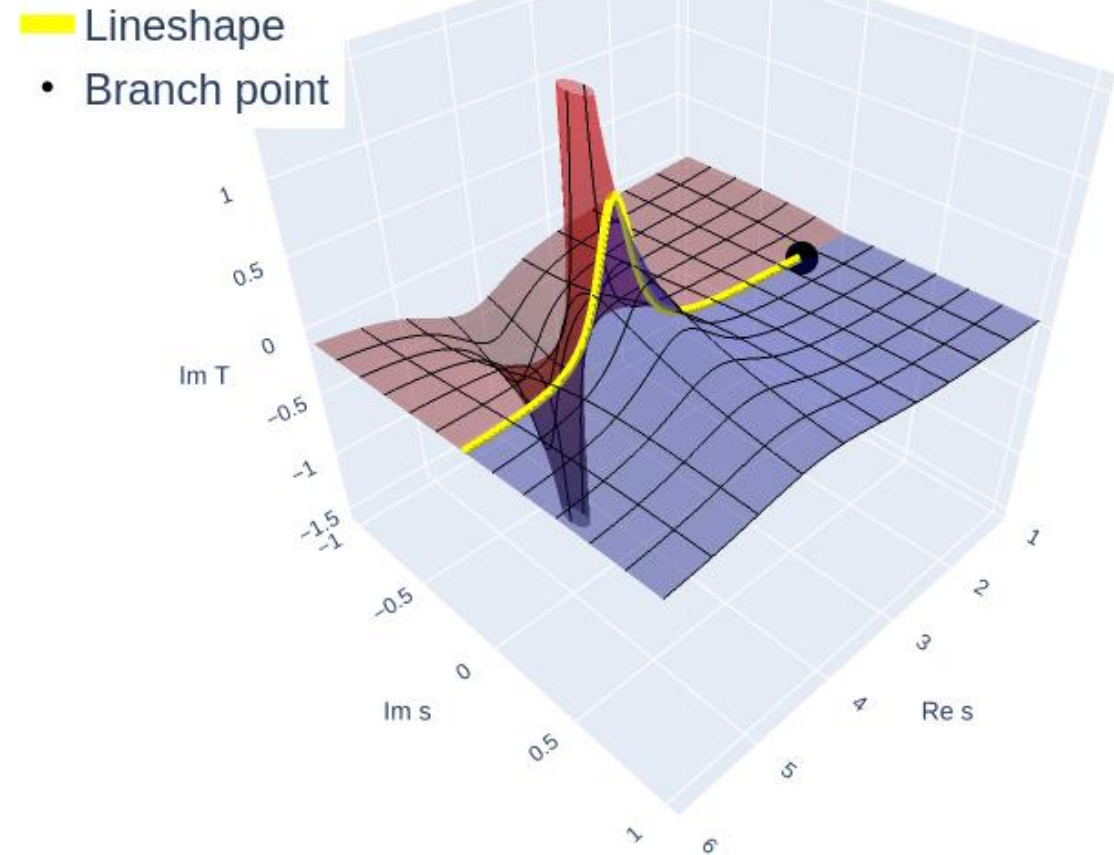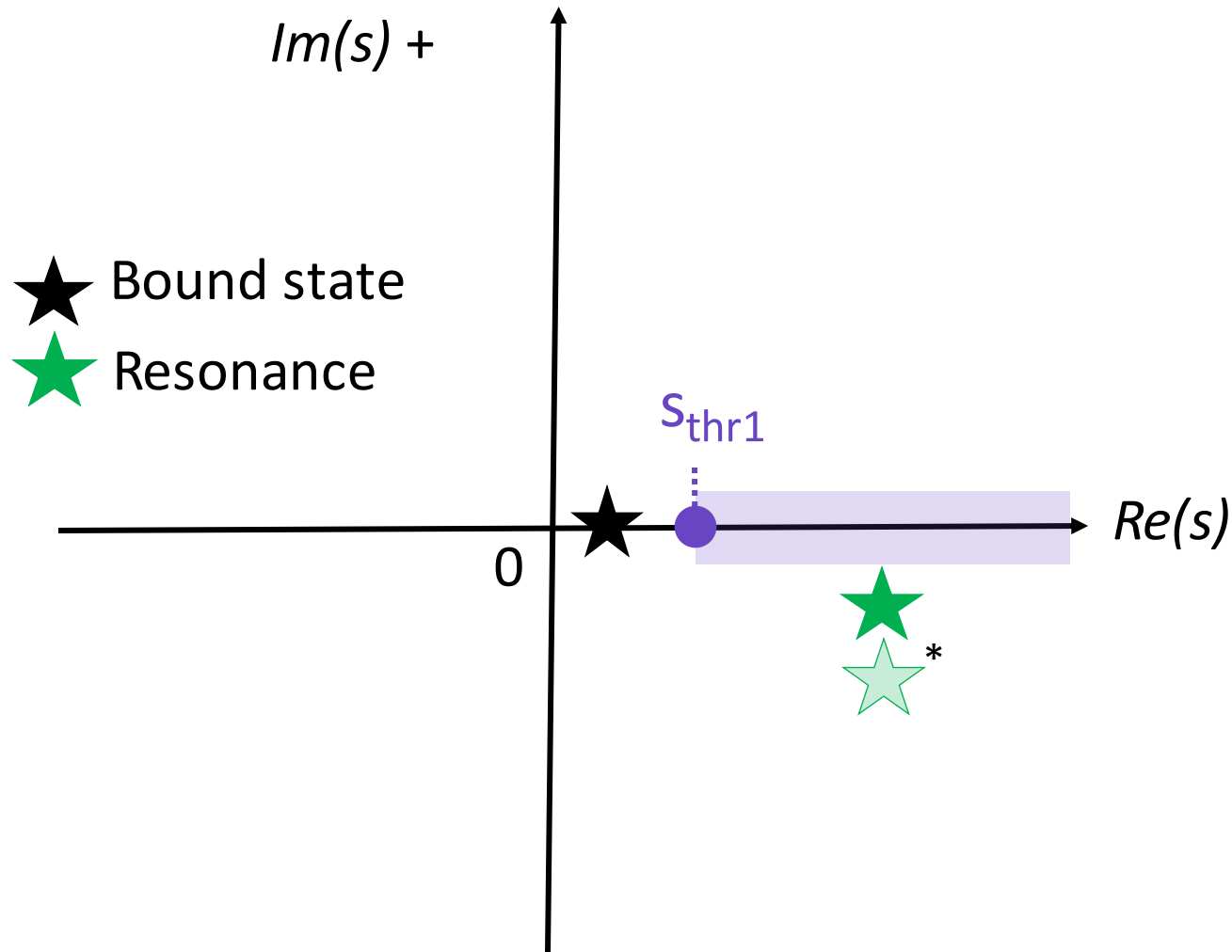**RUB**

Riemann sheets of the *T* matrix

- Inherits topology of phasespace factor => multivalued function

- "Choice" of solution cuts the complex plane along the *branch cut*

$$\rho = \sqrt{\left[1 - \left(\frac{m_a + m_b}{m}\right)^2\right]\left[1 - \left(\frac{m_a - m_b}{m}\right)^2\right]}$$
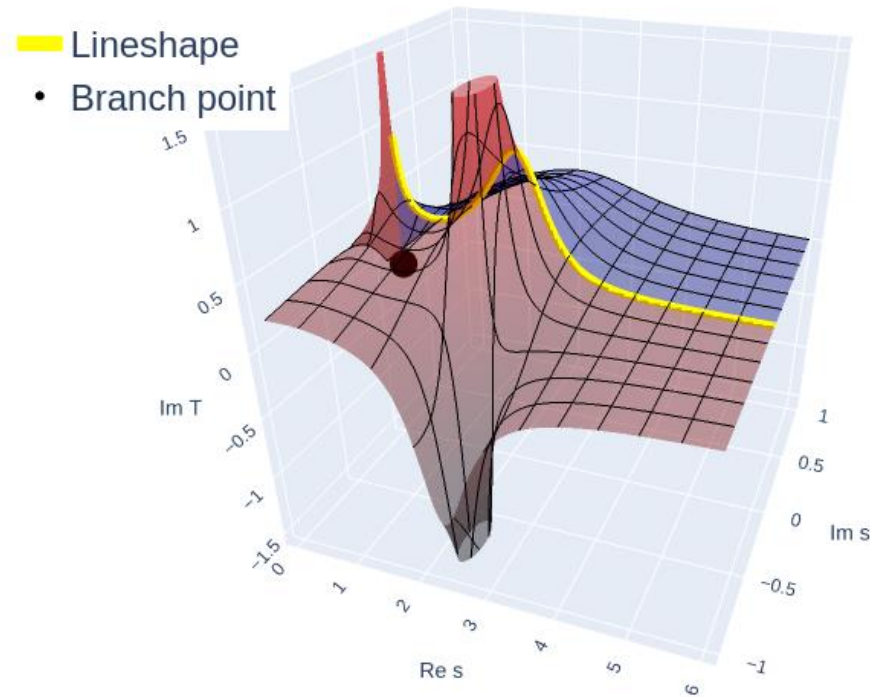
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Resonances in particle physics

Bound state ★
Resonance ★

s_{thr1}

$Im(s) +$
$Re(s)$
0

*

Lineshape
Branch point

Im T
Im s
Re s
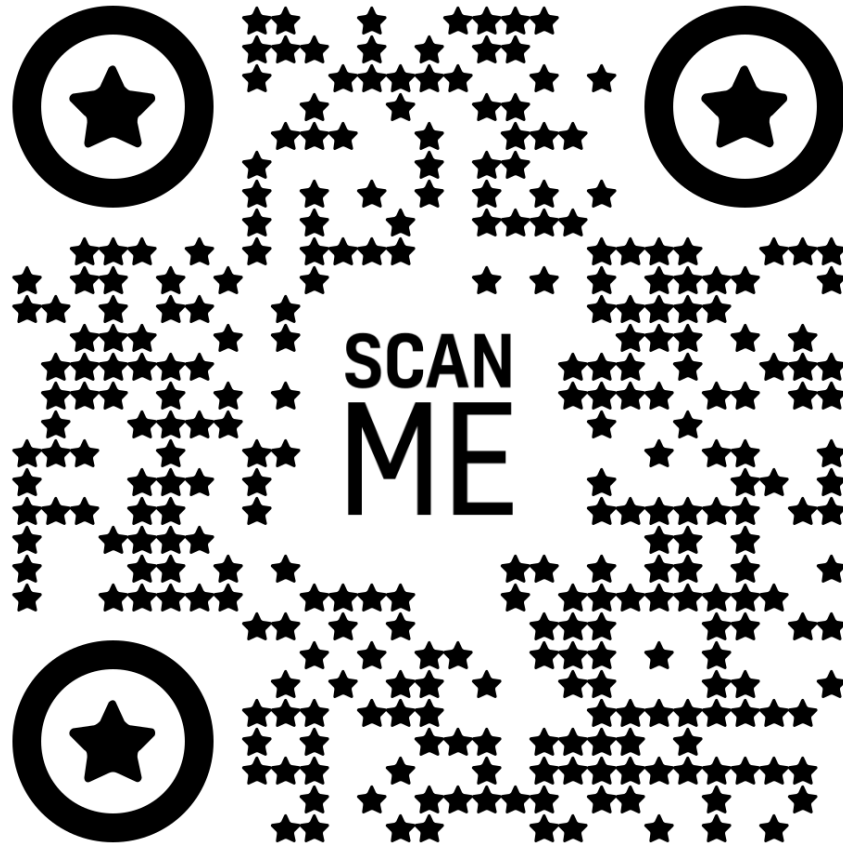
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Violation of analyticity

Singularity distorts lineshape

- **Idea:** Replace phase space factor by an analytic function

$$CM = Im(\rho)$$

Chew Mandelstam function

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Now finally a practical example!

https://compwa.github.io/report/027

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