

Closing Session

5th Graduate School on Astro-Particle Physics
Unifying view on cosmic interacting matter

Unifying view on cosmic interacting matter

SFB1491 - CIM

Cosmic Interacting Matters - From Source to Signal

- Plasma Physics, Neutrinos, Cosmic Rays, Magnetic Fields, Gravitational Waves, Multi-Messenger Astronomy, ...
- Deep Learning (*the new core competency for physicists*)
- **Many thanks to all lecturers!**

Slides Available on Indico

Timetable








	<	Sun 18/01	Mon 19/01	Tue 20/01	Wed 21/01	Thu 22/01	Fri 23/01	All days	>
	<div>  Print  PDF  Full screen  Detailed view  Filter </div>								
09:00	<div> Astrophysical Plasmas and Cosmic Ray Propagation (1/2) Daniel Verscharen  </div>								
10:00	<div> <i>Physikzentrum Bad Honnef</i> 09:00 - 10:30 </div>								
	<div> Coffee </div>								
	<div> <i>Physikzentrum Bad Honnef</i> 10:30 - 11:00 </div>								
11:00	<div> Astrophysical Plasmas and Cosmic Ray Propagation (2/2) Daniel Verscharen  </div>								

Photo collection

We collect photos at:

<https://tu-dortmund.sciebo.de/s/geQoxqYys8z4SnX>

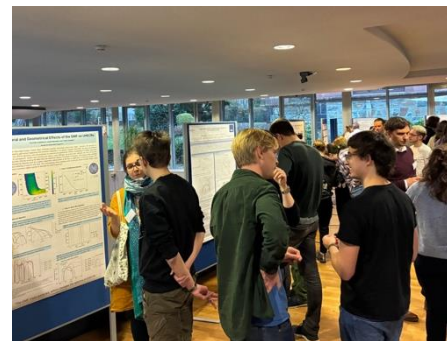
You can upload your own photos (if we are allowed to potentially post them on social media)

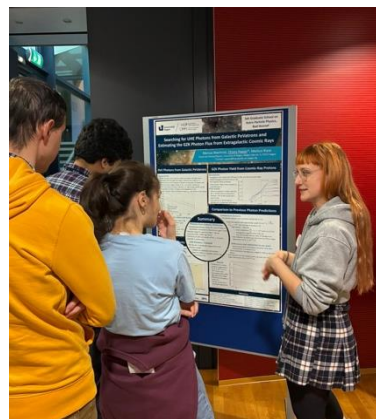
and

- Pay your drinks by 13:00

$$\begin{aligned}
\mathcal{L}_{SM} = & -\frac{1}{2}\partial_\nu g_\mu^a \partial_\nu g_\mu^a - g_\nu f^{abc} \partial_\mu g_\mu^a g_\mu^b g_\mu^c - \frac{1}{4}g_s^2 f^{abcd} g_\mu^a g_\mu^b g_\mu^c g_\mu^d - \partial_\nu W_\mu^+ \partial_\nu W_\mu^- \\
& M^2 W_\mu^+ W_\mu^- - \frac{1}{2}\partial_\mu Z_\mu^0 Z_\mu^0 - \frac{1}{2c_w^2} M^2 Z_\mu^0 Z_\mu^0 - \frac{1}{2}\partial_\mu A_\mu \partial_\mu A_\mu - igc_w (\partial_\nu Z_\mu^0 (W_\mu^+ W_\nu^- - \\
& W_\nu^+ W_\mu^-) - Z_\mu^0 (W_\mu^+ \partial_\nu W_\nu^- - W_\nu^+ \partial_\mu W_\mu^-) + Z_\mu^0 (W_\nu^+ \partial_\mu W_\mu^- - W_\mu^+ \partial_\nu W_\nu^-) - \\
& ig s_w (\partial_\nu A_\mu (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - A_\mu (W_\mu^+ \partial_\nu W_\nu^- - W_\nu^+ \partial_\mu W_\mu^-) + A_\mu (W_\nu^+ \partial_\mu W_\mu^- - \\
& W_\mu^+ \partial_\nu W_\nu^-)) - \frac{1}{2}g^2 W_\mu^+ W_\mu^- W_\nu^+ W_\nu^- + \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\mu^+ W_\nu^- + g^2 c_w^2 (Z_\mu^0 W_\mu^+ Z_\nu^0 W_\nu^- - \\
& Z_\mu^0 Z_\nu^0 W_\mu^+ W_\nu^-) + g^2 s_w^2 (A_\mu W_\mu^+ A_\nu W_\nu^- - A_\mu A_\nu W_\mu^+ W_\nu^-) + g^2 s_w c_w (A_\mu Z_\nu^0 (W_\mu^+ W_\nu^- - \\
& W_\nu^+ W_\mu^-) - 2A_\mu Z_\mu^0 W_\nu^+ W_\nu^-) - \frac{1}{2}\partial_\mu H \partial_\mu H - 2M^2 \alpha_h H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \\
& \beta_h \left(\frac{2M^2}{g^2} + \frac{2M}{g} H + \frac{1}{2}(H^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-) \right) + \frac{2M^4}{g^2} \alpha_h - \\
& g\alpha_h M (H^3 + H\phi^0 \phi^0 + 2H\phi^+ \phi^-) - \\
& \frac{1}{8}g^2 \alpha_h (H^4 + (\phi^0)^4 + 4(\phi^+ \phi^-)^2 + 4(\phi^0)^2 \phi^+ \phi^- + 4H^2 \phi^+ \phi^- + 2(\phi^0)^2 H^2) - \\
& gM W_\mu^+ W_\mu^- H - \frac{1}{2}g \frac{M}{c_w} Z_\mu^0 Z_\mu^0 H - \\
& \frac{1}{2}ig (W_\mu^+ (\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W_\mu^- (\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0)) + \\
& \frac{1}{2}g (W_\mu^+ (H \partial_\mu \phi^- - \phi^- \partial_\mu H) + W_\mu^- (H \partial_\mu \phi^+ - \phi^+ \partial_\mu H)) + \frac{1}{2}g \frac{1}{c_w} (Z_\mu^0 (H \partial_\mu \phi^0 - \phi^0 \partial_\mu H) + \\
& M (\frac{1}{c_w} Z_\mu^0 \partial_\mu \phi^0 + W_\mu^+ \partial_\mu \phi^- + W_\mu^- \partial_\mu \phi^+)) - ig \frac{2c_w^2}{c_w} M Z_\mu^0 (W_\mu^+ \phi^- - W_\mu^- \phi^+) + ig s_w M A_\mu (W_\mu^+ \phi^- - \\
& W_\mu^- \phi^+) - ig \frac{1-2c_w^2}{2c_w} Z_\mu^0 (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) + ig s_w A_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \\
& \frac{1}{4}g^2 W_\mu^+ W_\mu^- (H^2 + (\phi^0)^2 + 2\phi^+ \phi^-) - \frac{1}{8}g^2 \frac{1}{c_w} Z_\mu^0 Z_\mu^0 (H^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+ \phi^-) - \\
& \frac{1}{2}g^2 \frac{c_w^2}{c_w} Z_\mu^0 \phi^0 (W_\mu^+ \phi^- + W_\mu^- \phi^+) - \frac{1}{2}ig^2 \frac{2c_w^2}{c_w} Z_\mu^0 H (W_\mu^+ \phi^- - W_\mu^- \phi^+) + \frac{1}{2}g^2 s_w A_\mu \phi^0 (W_\mu^+ \phi^- + \\
& W_\mu^- \phi^+) + \frac{1}{2}ig^2 s_w A_\mu H (W_\mu^+ \phi^- - W_\mu^- \phi^+) - g^2 \frac{2c_w^2}{c_w} (2c_w^2 - 1) Z_\mu^0 A_\mu \phi^+ \phi^- - \\
& g^2 s_w^2 A_\mu A_\mu \phi^+ \phi^- + \frac{1}{2}ig s_w \lambda_\mu^a (g_\mu^a \gamma^\mu g_\mu^a) g_\mu^a - \bar{e}^\lambda (\gamma^\mu \partial_\mu + m_e^\lambda) e^\lambda - \bar{\nu}^\lambda (\gamma^\mu \partial_\mu + m_\nu^\lambda) \nu^\lambda - \bar{u}_j^\lambda (\gamma^\mu \partial_\mu + \\
& m_u^\lambda) u_j^\lambda - \bar{d}_j^\lambda (\gamma^\mu \partial_\mu + m_d^\lambda) d_j^\lambda + ig s_w A_\mu (-\bar{e}^\lambda \gamma^\mu e^\lambda + \frac{2}{3}(\bar{u}_j^\lambda \gamma^\mu u_j^\lambda) - \frac{1}{3}(\bar{d}_j^\lambda \gamma^\mu d_j^\lambda)) + \\
& \frac{ig}{4c_w} Z_\mu^0 \{ (\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{e}^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{d}_j^\lambda \gamma^\mu (\frac{2}{3}s_w^2 - 1 - \gamma^5) d_j^\lambda) + \\
& (\bar{u}_j^\lambda \gamma^\mu (1 - \frac{2}{3}s_w^2 + \gamma^5) u_j^\lambda) \} + \frac{ig}{2\sqrt{2}} W_\mu^+ ((\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) U^{lep}_{\lambda\kappa} e^\kappa) + (\bar{u}_j^\lambda \gamma^\mu (1 + \gamma^5) C_{\lambda\kappa} d_j^\kappa)) + \\
& \frac{ig}{2\sqrt{2}} W_\mu^- ((\bar{e}^\kappa U^{lep\dagger}_{\kappa\lambda} \nu^\lambda + \gamma^5) \nu^\lambda) + (\bar{d}_j^\kappa C_{\kappa\lambda}^\dagger \gamma^\mu (1 + \gamma^5) u_j^\lambda)) + \\
& \frac{ig}{2M\sqrt{2}} \phi^+ (-m_e^\kappa (\bar{\nu}^\lambda U^{lep}_{\lambda\kappa} - \gamma^5) e^\kappa) + m_\nu^\kappa (\bar{\nu}^\lambda U^{lep}_{\lambda\kappa} (1 + \gamma^5) e^\kappa) + \\
& \frac{ig}{2M\sqrt{2}} \phi^- (m_e^\lambda (\bar{e}^\lambda U^{lep\dagger}_{\lambda\kappa} (1 + \gamma^5) \nu^\kappa) - m_\nu^\kappa (\bar{e}^\lambda U^{lep\dagger}_{\lambda\kappa} (1 - \gamma^5) \nu^\kappa) - \frac{g}{2} \frac{m_\nu^\lambda}{M} H (\bar{\nu}^\lambda \nu^\lambda) - \\
& \frac{g}{2} \frac{m_\nu^\lambda}{M} H (\bar{e}^\lambda e^\lambda) + \frac{ig}{2} \frac{m_\nu^\lambda}{M} \phi^0 (\bar{e}^\lambda \gamma^5 e^\lambda) - \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^\mu (1 - \gamma^5) \bar{\nu}_\kappa - \\
& \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^\mu (1 - \gamma^5) \bar{\nu}_\kappa + \frac{ig}{2M\sqrt{2}} (\bar{d}_j^\kappa C_{\lambda\kappa} (1 - \gamma^5) d_j^\kappa) + m_\nu^\kappa (\bar{u}_j^\lambda C_{\lambda\kappa} (1 + \gamma^5) d_j^\kappa) + \\
& \frac{ig}{2M\sqrt{2}} \phi^- (m_d^\lambda (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 + \gamma^5) u_j^\kappa) - m_u^\kappa (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 - \gamma^5) u_j^\kappa) - \frac{g}{2} \frac{m_\nu^\lambda}{M} H (\bar{u}_j^\lambda u_j^\lambda) - \\
& \frac{g}{2} \frac{m_\nu^\lambda}{M} H (\bar{d}_j^\lambda d_j^\lambda) + \frac{ig}{2} \frac{m_\nu^\lambda}{M} \phi^0 (\bar{u}_j^\lambda \gamma^5 u_j^\lambda) + \frac{ig}{2} \frac{m_\nu^\lambda}{M} \phi^0 (\bar{d}_j^\lambda \gamma^5 d_j^\lambda) - \bar{\psi}^c G^b g_\mu^c + \\
& \bar{X}^+ (\partial^2 - M^2) X^+ + \bar{X}^- (\partial^2 - M^2) X^- + \partial_\mu \bar{X}^+ \partial_\mu X^+ + \partial_\mu \bar{X}^- \partial_\mu X^- - \\
& \partial_\mu \bar{X}^+ X^0 + ig s_w W_\mu^+ \partial_\mu X^+ - \partial_\mu \bar{X}^0 X^+ + ig s_w W_\mu^- \partial_\mu X^- - \partial_\mu \bar{X}^0 X^- + ig s_w A_\mu \partial_\mu X^+ - \partial_\mu \bar{X}^0 X^+ + ig s_w A_\mu \partial_\mu X^- - \partial_\mu \bar{X}^0 X^- \\
& \partial_\mu \bar{X}^+ X^- - \frac{1}{2}gM (\bar{X}^+ X^+ H + \bar{X}^- X^- H + \frac{1}{c_w} \bar{X}^0 X^0 H) + \frac{1-2c_w^2}{2c_w} igM (\bar{X}^+ X^0 \phi^+ - \bar{X}^- X^0 \phi^-) + \\
& \frac{1}{2c_w} igM (\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-) + igM s_w (\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-) + \\
& \frac{1}{2}igM (\bar{X}^+ X^0 \phi^0 - \bar{X}^- X^0 \phi^0) .
\end{aligned}$$

Any questions
so far?









Es ist besser die Entdeckung einer
Glasche als die eines Stern's



Social Media - LinkedIn

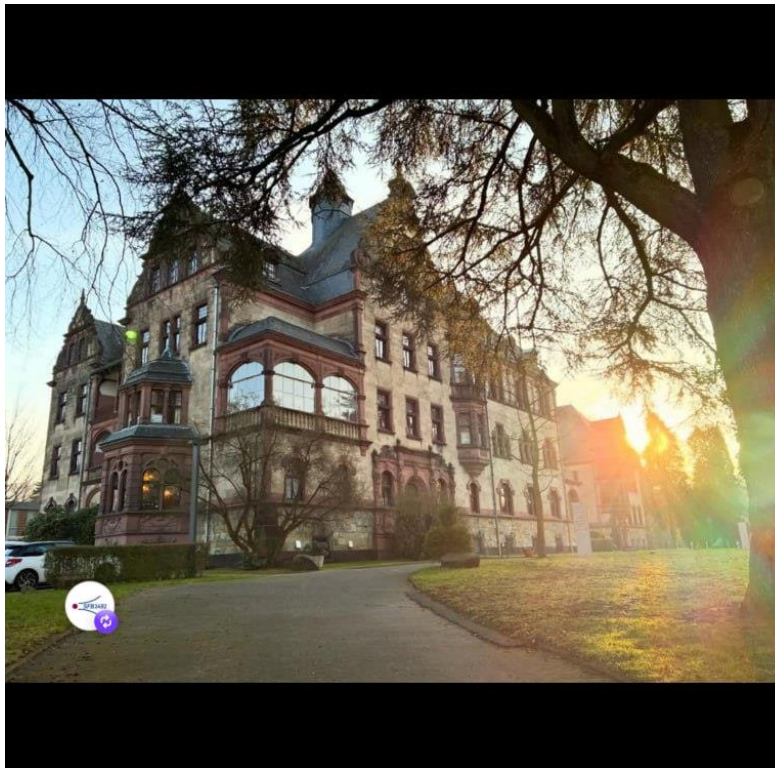


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Social Media - Instagram



 **rapp.center**
Bad Honnef Am Rhein, Nordrhein-Westfalen, Germany

 rapp.center (English version in comments)

Diese Woche findet die „5th Graduate School on Astro-Particle Physics: Unifying views on cosmic interactinv matter“ im Physikzentrum in Bad Honnef statt. 📅

In diesem wunderschönen Gebäude können über 80 Teilnehmende, die Vortragenden und das Organisationsteam Vorträge, Posterpräsentationen und Exkursionen genießen ... 🌟👤

Organisiert wird die Graduate School von RAPP Pls im Rahmen des @sfb1491


@dpgphysik #physics #astrophysics #astroparticlephysics #dpgphysik #science

22 Std.

 rapp.center This week, the 5th Graduate School on Astro-Particle Physics: Unifying Views on Cosmic Interacting Matter is taking place at the Physikzentrum in Bad Honnef. 📅

In this beautiful building, more than 80 participants, guest speakers, and the organizing team can enjoy lectures, poster presentations, and excursions ... 🌟👤

♥️ 💬 ↻ 📌

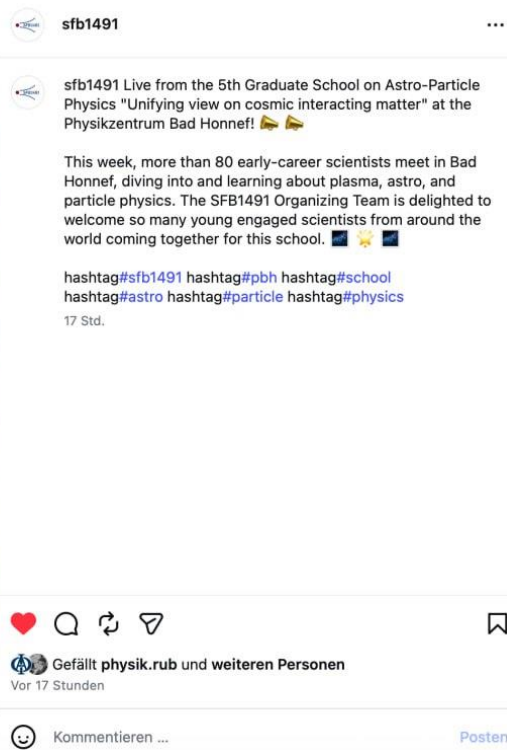
 Gefällt sfb1491 und weiteren Personen

Vor 22 Stunden

 Kommentieren ... Posten



Social Media - Instagram



Poster Prize



Ruhr
Astro
Particle
Plasma
Physics Center

Understanding the Transformer-Based Neural Network to Analyze Extensive Air Showers at the Pierre Auger Observatory

Ronja Westphalen, Niklas Langer, Josina Schulte, Martin Erdmann

a member of the Pierre Auger Collaboration

Pierre Auger Observatory

- world's largest observatory for extreme rays (collected in Marikana, Argentina)
- total detector setup:
 - fluorescence detector (FD)
 - surface detector (SD) with 1600 kg/m² of tungsten-gel scintillator
- extensive air shower measurement with SD
- 1000 km² of surface detector with 1600 stations and 80000 channels
- in evolution with deep neural network

Architecture of the Transformer-Based Neural Network

- combined with and trained on independent depth of shower maximum X_{max} and muon content μ , from 5000 simulations (*)
- trained with: 100 000 FD+SD simulation (*) X_{max} 1.5 km, μ 100000 \pm 500
- trained with: 100 000 FD+SD simulation (*) X_{max} 1.5 km, μ 100000 \pm 500
- 100 000 FD+SD simulation (*) X_{max} 1.5 km, μ 100000 \pm 500
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(*) 100 000 FD+SD simulation (*) X_{max} 1.5 km, μ 100000 \pm 500

Time Series Analysis (on simulated total, Transformer Prediction)

Spatial Analysis (on single station, Transformer Prediction)

What is 'Attention'?

- attention mechanism is a way to weight the input data based on its relevance to the output
- attention weights are calculated based on the input data and the output data
- attention weights are used to calculate the output data
- attention weights are used to calculate the output data

Results: Time Series Analysis

- total energy prediction
- total energy prediction
- total energy prediction
- total energy prediction

Results: Spatial Analysis

- total energy prediction
- total energy prediction
- total energy prediction
- total energy prediction

Results: Attention Matrix and Total Attention

- attention matrix is a way to weight the input data based on its relevance to the output
- attention weights are calculated based on the input data and the output data
- attention weights are used to calculate the output data
- attention weights are used to calculate the output data

Results: Impact of Hadronic Interaction Models

- total energy prediction
- total energy prediction
- total energy prediction
- total energy prediction

Conclusion & Outlook

- total energy prediction
- total energy prediction
- total energy prediction
- total energy prediction

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Good Bye

and have a safe trip home