Studies of the star configurations at intermediate energies with the use of the BINA detector

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What is the Space Star Anomaly

- **Space Star** is a specific configuration where momenta of the final state nucleons form an equilateral triangle and the decay plane is perpendicular to the beam direction.

- The effect was discovered in 1989 in n+d breakup by Erlangen group (Strate et al.) (30% above the predictions).

- It was confirmed TUNL in 1996 (Setze et al.)

- The effect is opposite in p+d breakup (15% below theory).

- Mainly s-wave of binary NN interaction.

- Energy too low for 3NF to be apparent (max. few %).

- Coulomb force and relativistic effects negligible.

Ohnaka et al. measured the dependence of the cross section on inclination angle.

By varying $\alpha$ one finds the discrepancy peaks at the Space Star ($90^\circ$).

Forward and Backward Plane Star configurations follow the theoretical predictions.

Energy dependence

- The highest ever measured p+d energies are 19 and 65 MeV
- In both cases the data are consistent with the theoretical predictions
- The effect appears at energies about 9-13 MeV
- What about higher energies?

Y. Eguchi. Fb19 conference presentation.
CD-Bonn+$\Delta$+C

- CD-Bonn is a realistic potential
- Addition of $\Delta$ excitation enables to describe 3NF
- Coulomb effects are introduced by A. Deltuva
A $4\pi$ geometry facilitates a simultaneous measurement of a set of the star configurations with different $\alpha \rightarrow$ the same luminosity.

- Axial symmetry makes possible to rotate the configuration about the beam axis $\rightarrow$ systematic effect
- MWPC and Wall $\theta \in 10-35^\circ$ (resolution $0.7^\circ$)
- Ball $\theta \in 40-165^\circ$ (resolution $10^\circ$)
First pre-preliminary $d(160\text{MeV}) + p$ results

$\alpha = 20^\circ$

$\alpha = 40^\circ$

$\alpha = 60^\circ$

Current status:

The theory is presented for the exact value of $\alpha$, is to be averaged over all accepted configurations.
Another rotation angle $\beta$

- All $\alpha > 60^\circ$ configurations in p+d are at $\theta > 40^\circ$
- Poor resolution in ball-ball coincidences
- Definition of $\beta$ (rotation angle about the axis perpendicular to the reaction plane) enables to analyse them as wall-ball coincidences
Detection possibility for BINA

Thanks to the courtesy of A. Szadzinski
The $\beta$ angle is equivalent of azimuthal angle for $\alpha = 90^\circ$

Rotation by $\alpha$ changes only the angle of one proton at the values $\beta = 30^\circ$ and $\beta = 150^\circ$

Thanks to the courtesy of A. Szadzinski
The project aims at obtaining cross sections for deuteron on proton breakup for energies 50, and 80 MeV/nucleon (already measured), as well as for proton beam of energy 108, 135, and 160 MeV (partially measured).

The analysis should take into account also dependence on $\beta$ angle.

This will fill the gap in the energy scan of the process and find whether the SSA is characteristic only to the lowest energies.

Some new theoretical predictions are awaited (theories calculated in relativistic framework, $\chi$EFT).

The experiment starts this month.