AZIMUTHAL DISTRIBUTION of “INCLUSIVE” PIONS PRODUCED in p-p COLLISIONS with ALIGNED SPINS.

Zulkarneev R.Ya.
(JINR, Dubna)

ASI,Prague july 2008

The aims of the study:

- **to receive the inclusive pion production cross-section in the process**

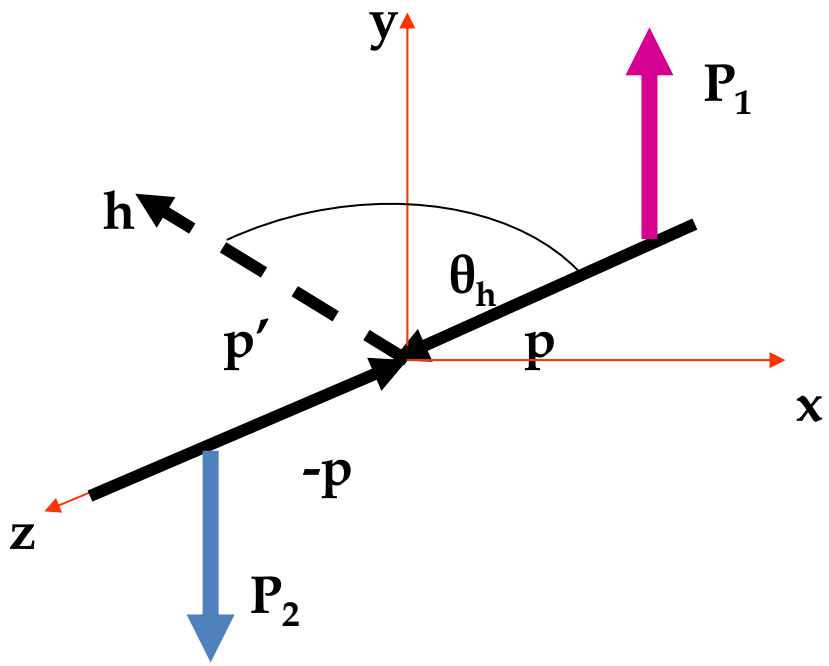
$$p\uparrow + p\downarrow \rightarrow \pi + \ldots$$

as function of the colliding beams polarizations,

- **to find azimuthal angle distribution of the pions in case if the beam polarizations have equal modules but oppositely directed orientations of its vectors,**

- **to make comparison the forms of azimuthal distributions known from spin physics with those arising out of heavy ion collisions at high energies.**

Coordinate system & basic vectors:



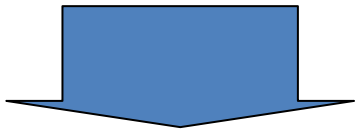
$$\mathbf{n} = [(\mathbf{p}/p) \times (\mathbf{p}'/p')] / \sin\theta_h$$

$$\mathbf{m} = (\mathbf{p}/p - \mathbf{p}'/p)/\sqrt{2}\ ,$$

$$\mathbf{l} = (\mathbf{p}/p + \mathbf{p}'/p)/\sqrt{2}.$$

Requirements for the cross-section :

- **to be scalar function of P_1 , P_2 and n, m, l**
- **to comply with Pauli principle ,**
- **to comply with P- conservation.**



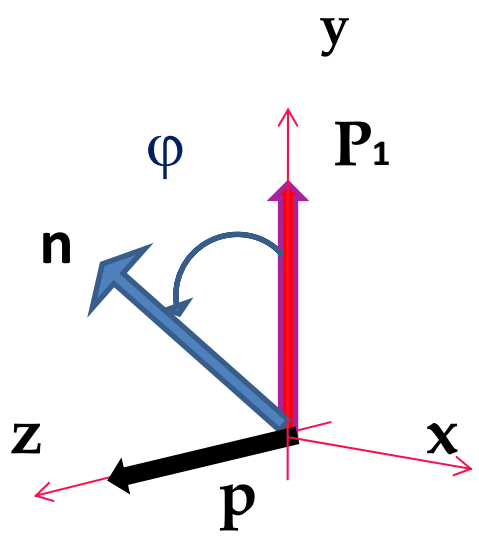
The phenomenological type of cross-section is

$$I(p\ p \rightarrow h+\ldots) = I_0 + I_1(P_1+P_2)\,n + I_2(P_1 n)\,(P_2 n)$$

$$+I_3(P_1 m)(P_2 m) + I_4(P_1 l)\,(P_2 l) + I_5((P_1 m)\,(P_2 l) + (P_1 l)\,(P_2 m)) .$$

$I_{0\text{-}5}$ _ - functions of p^2, $(p')^2$ and pp'

Azimuthal (φ) distribution of produced hadron



$I(\varphi; \theta_h = \pi/2; P_1 = -P_2) =$

$$I_0 - (1/2)\, I_2\, P^2 \cos^2\varphi + ((1/2)I_3 + I_4 + I_5)\, P^2 \sin^2\varphi\,,$$

Once more sort of spin asymmetry (for s =1/2):

- **no the terms of $\sim \cos\varphi$;** $(I(\varphi = 0) = I(\varphi = \pi))$
- **quadratic dependences of $\cos\varphi$, $\sin\varphi$**

Table 1.Azimuthal distributions of particles produced in hadron-hadron and nucleus-nucleus collisions

$P_1 = P_2 = 0$	$P_1 , P_2 \neq 0$	$P_1 = - P_2 \neq 0$	Hadron collisions, (No collective effects?)
isotropy	$(1 + a \cos \varphi)$	$(1 - b \cos^2 \varphi + c \sin^2 \varphi)$	

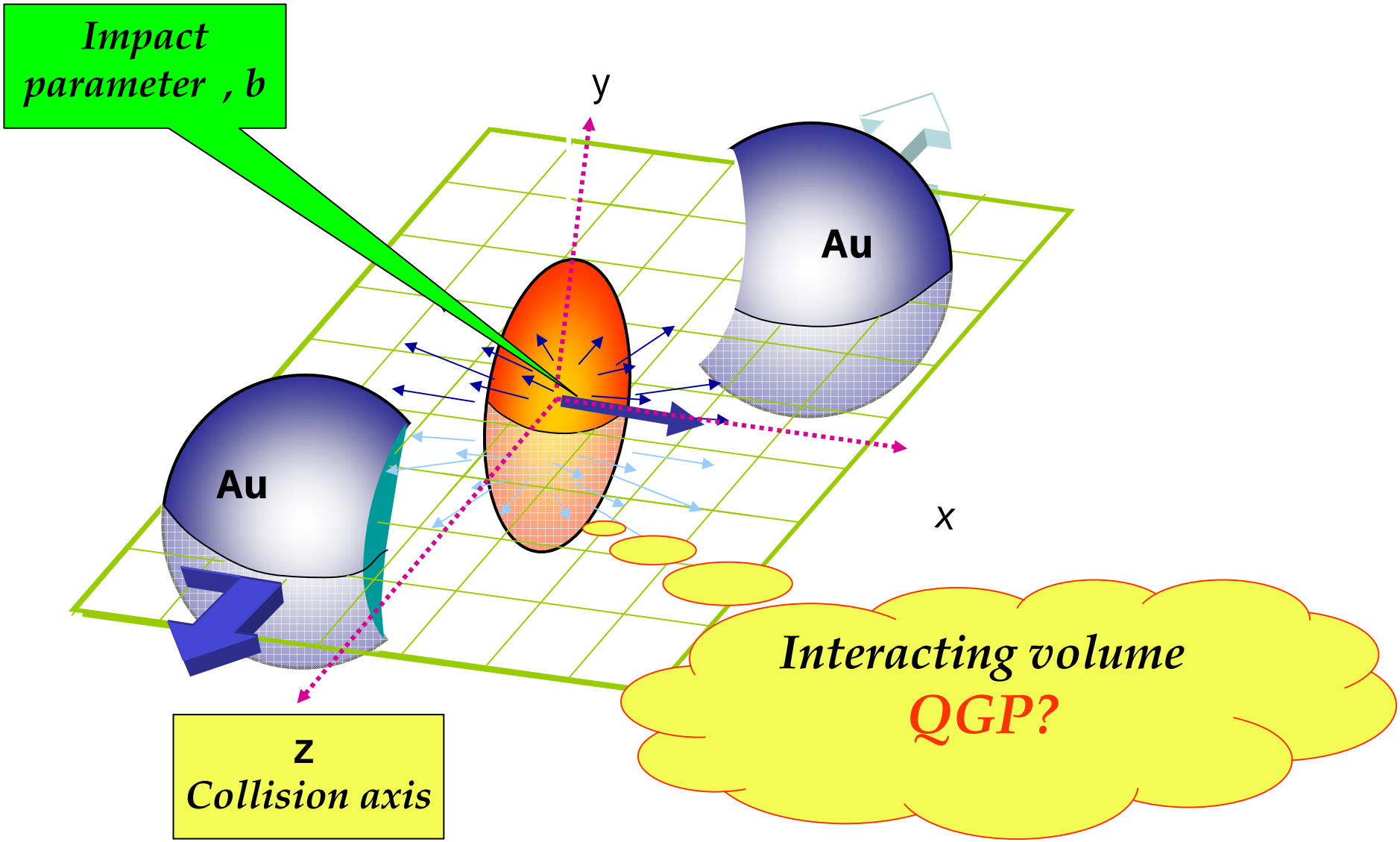
No flows	Directed flow	elliptic flow	Hot & dense hadron matter – fireball: collective interaction effects, thermalised constituents.
isotropy	$(1 + A \cos \varphi)$	$(1 + B \cos^2 \varphi - B \sin^2 \varphi) = (1 + B \cos 2 \varphi)$	

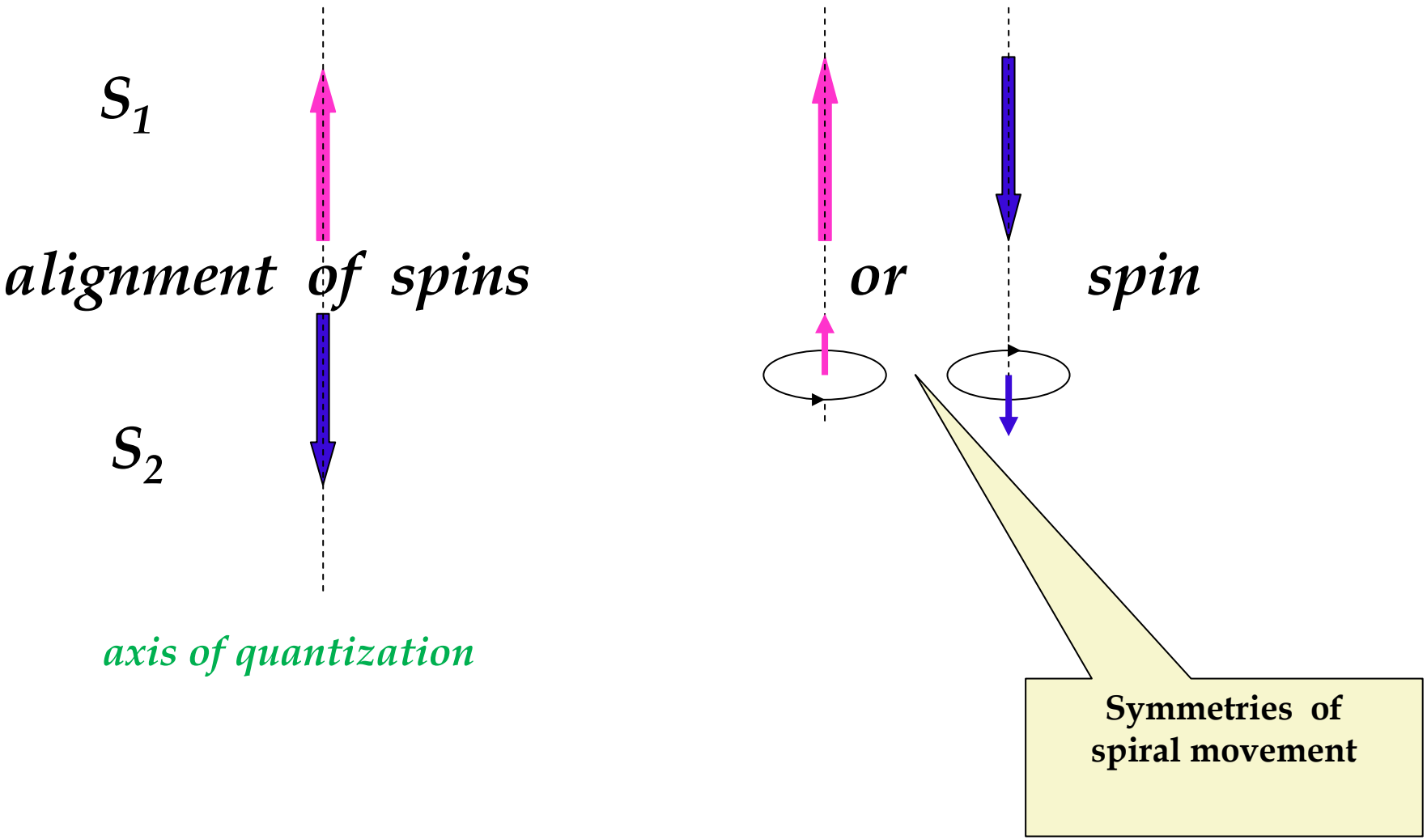
Instead of the summary

Is that analogy an accidental situation?

If not, it looks like

the fireball produced in heavy ion collisions at RHIC energies gets some portion of the rotational movement- angular momentum.


Impact parameter , b
y
Au
Au
x
Interacting volume
QGP?
z
Collision axis


S_1
alignment of spins
S_2
axis of quantization
or
spin
Symmetries of
spiral movement