The Resonance Spectroscopy Group

(reported by Kamal K. Seth)

Present : Baldini, Bugg, Joffe, Mebreveli, Page, Peters, Roethel, Seth, Wiedner, Zweber.

The research theme of this group is to elucidate

confinement

gluonic degrees of freedom.

by studying the relevant mesonic structures.

DEFINING THE ENERGY DOMAIN OF INTEREST

* No new data required for masses < 1.5 GeV.
  ∴ No stopped $\bar{p}$ needed
* Cannot find enough interest in charmed baryon pair production $\Lambda_c \bar{\Lambda}_c \rightarrow \Omega_c \bar{\Omega}_c$, to justify $P(\bar{p}) > 10$ GeV/c.
  Advantages: cost savings, easier electron cooling < 10 GeV/c

THE MASS REGIONS:

(1) $1.5 \text{ GeV} \leq M \leq 2.5$ GeV $(P(\bar{p}) < 2.2$ GeV/c)

Formation and production experiments.

Goal is not to find one more $q\bar{q}$ resonance (51+37 already known), but to clarify those ambiguities which relate to the identification and study of hybrids and glueballs.

Use of polarized targets advocated. Will require extracted beam of $\bar{p}$. Currently low priority.

Polarized gas target developments may obviate extraction.

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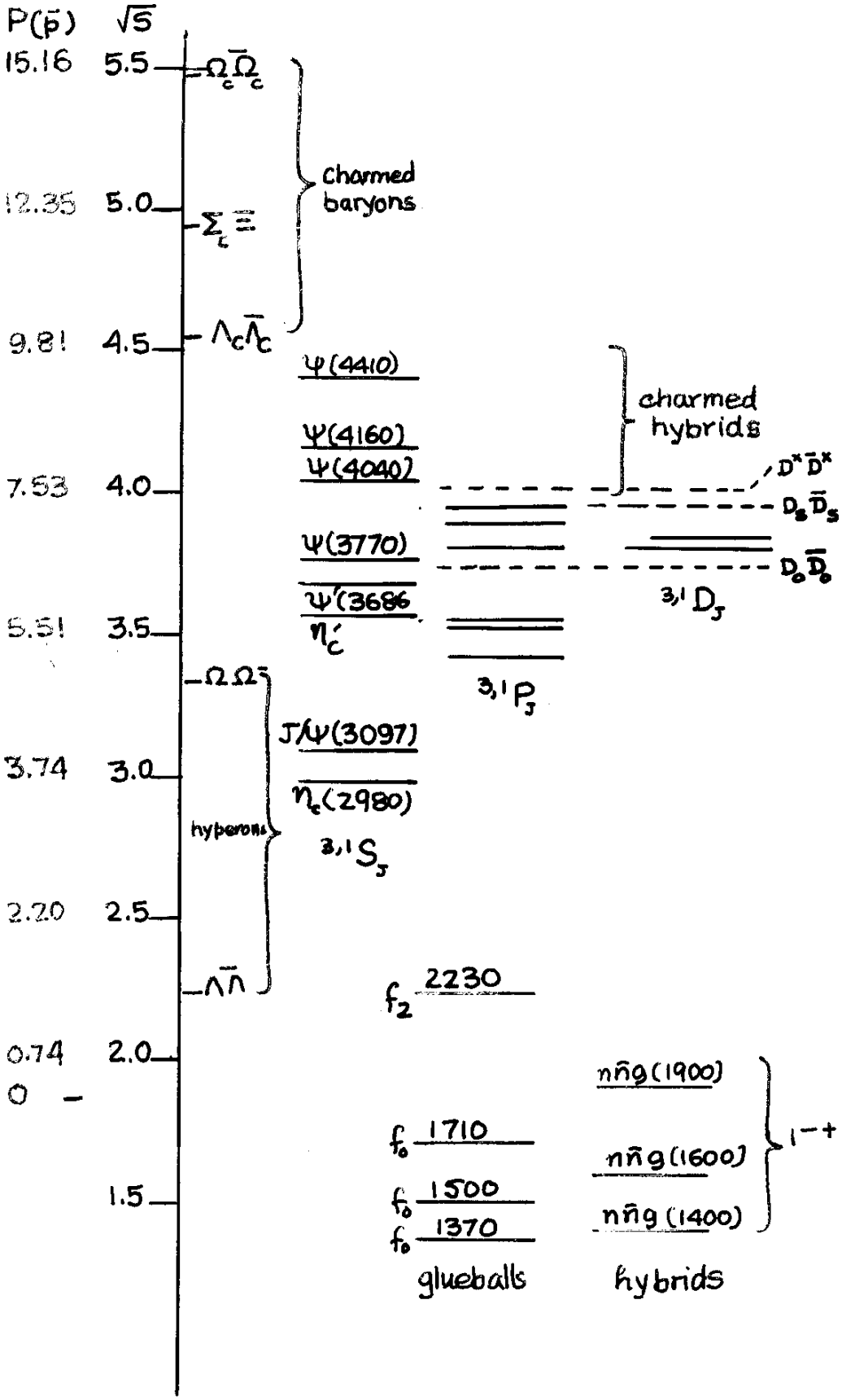
P(p̄) √s
15.16 5.5
12.35 5.0
9.81 4.5
7.53 4.0
5.51 3.5
3.74 3.0
2.20 2.5
0.74 2.0
0 −
1.5
$\Omega_c\bar{\Omega}_c$
$\Sigma_c\bar{\Xi}$
$\Lambda_c\bar{\Lambda}_c$
charmed baryons
$\Omega\bar{\Omega}$
$\Lambda\bar{\Lambda}$
hyperons
ψ(4410)
ψ(4160)
ψ(4040)
ψ(3770)
ψ'(3686)
η_c'
J/ψ(3097)
η_c(2980)
$^{3,1}S_J$
$^{3,1}P_J$
$^{3,1}D_J$
charmed hybrids
$D^*\bar{D}^*$
$D_s\bar{D}_s$
$D\bar{D}$
f_2 2230
f_0 1710
f_0 1500
f_0 1370
glueballs
$n\bar{n}g$(1900)
$n\bar{n}g$(1600)
$n\bar{n}g$(1400)
1^{-+}
hybrids

(2) $2.8\ \text{GeV} \lesssim M \lesssim 4.5\ \text{GeV}$ (i.e $P(\bar{p}) = 3.1\ \text{GeV/c} \rightarrow 10\ \text{GeV/c}$)

Region of maximum interest. Contains states of

a) bound $c\bar{c}$ below 3.73 GeV ($D\bar{D}$ break-up)

b) contains narrow $c\bar{c}$ states above $D\bar{D}$ threshold

c) contains the only unmixable glueball (4.1 GeV)

d) contains charmed hybrids

e) contains normal hyperons ($\Xi\bar{\Xi}$, $\Omega\bar{\Omega}$)

Do not (generally) need extracted beam.

REQUIREMENTS & THEIR IMPACT.

Need highest luminosity (impact on detector design)

Need ~4π acceptance (impact on target design)

* Did not consider colliding beam.

Did not consider D or τ physics.

The hydrogen pellet target

A pure liquid hydrogen jet, emerging through a glass nozzle with an inner diameter of 40 μm at near triple point conditions of hydrogen is broken up into uniformly sized and equally spaced drops by means of acoustical excitation of the nozzle. The velocity of the jet is 10 m/s and the production rate about 68 kHz. By keeping the pressure in the drop formation region slightly below the triple point pressure, a frozen shell is allowed to develop on the drops prior to their entry through a millimeter wide 6 cm long tube into vacuum. There, the velocity is increased to about 60 m/s due to gas drag acceleration. Purely liquid drops would be shattered in the interaction with the gas.

A stable and intense beam of pellets has been injected into vacuum. A lateral spread of the pellets after 1.4 meter flight in vacuum of 2 mm was obtained.

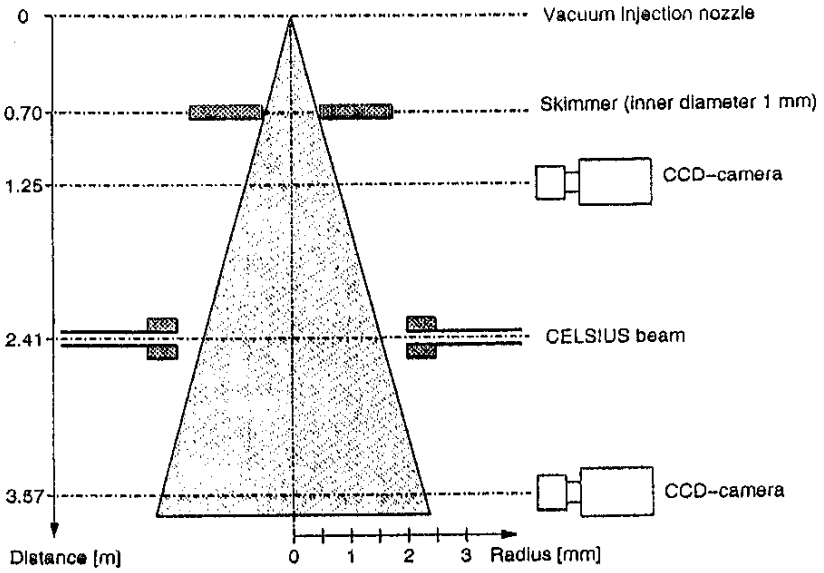

Fig. 4 Pellet beam diameter along the pellet beam path

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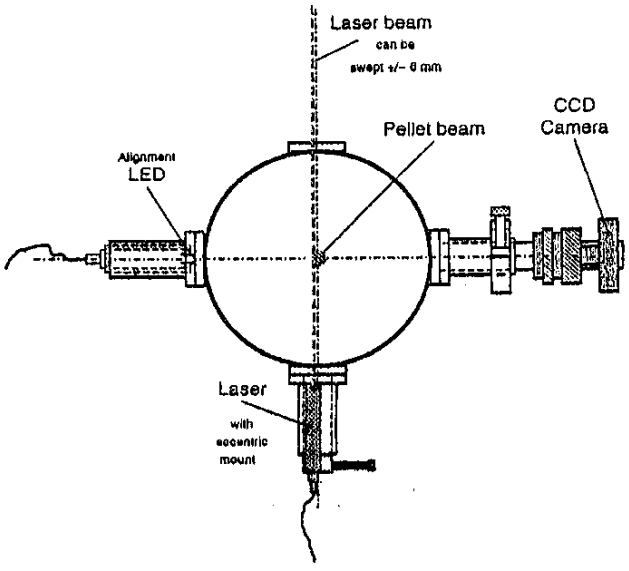


Fig. 5 The diagnostics for alignment of the pellet beam

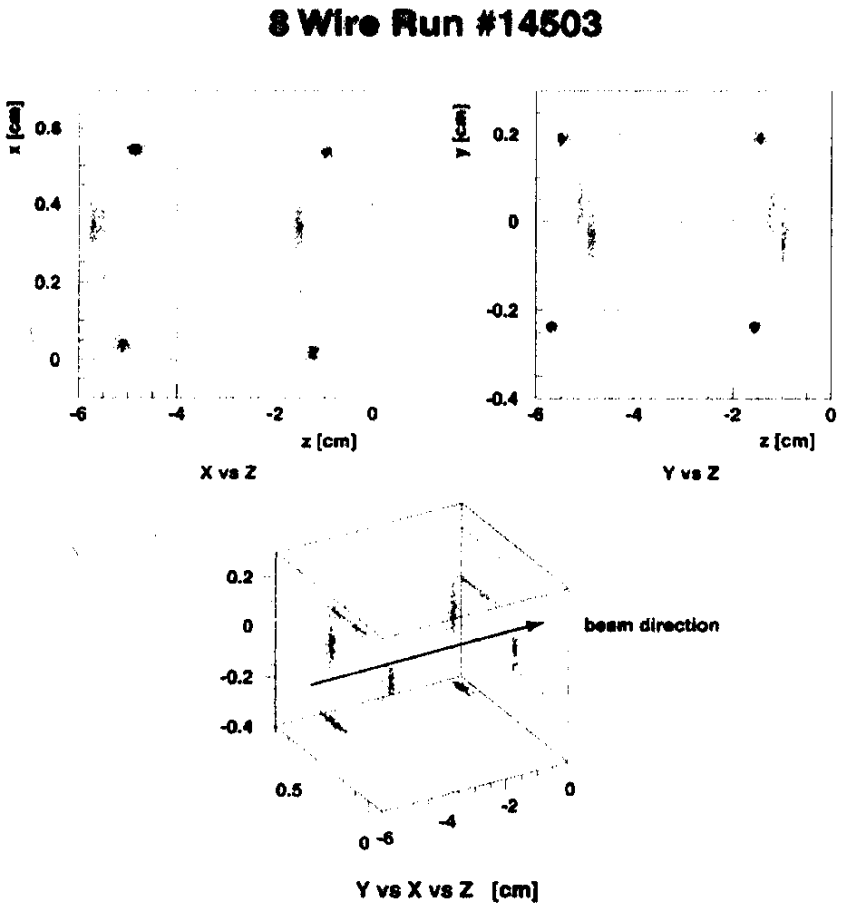
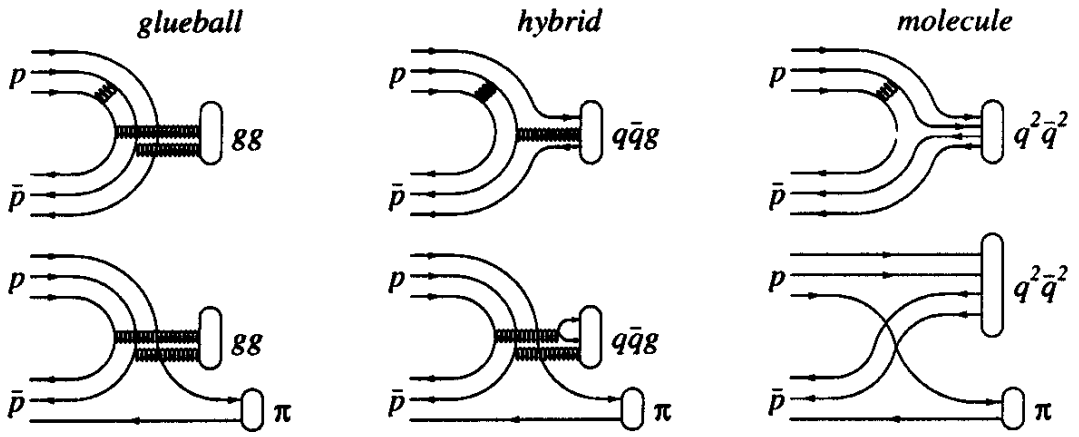


Fig 4: Reconstructed target vertex positions using the Micro-Vertex system

(From HERAB (courtesy J. Rosen)

QCD EXOTICS



Antiproton-proton annihilation is an ideal potential source of exotics, both in formation and production modes.

Where do we expect these objects? (n = u,d)

Four quark	Hybrids(1^{-+})	Glueballs (ggg)
$n\bar{n} \cdot n\bar{n}$: 1.4 GeV*	$n\bar{n}g$: 1.3 - 2.5 GeV*	0^{++} : 1.5 - 1.7 GeV*
$s\bar{s} \cdot s\bar{s}$: 2.4 GeV	$s\bar{s}g$: 1.8 - 3.0 GeV	2^{++} : 2.0 - 2.5 GeV
$c\bar{c} \cdot s\bar{s}$: 4.5 GeV	$c\bar{c}g$: 3.3 - 5.3 GeV	0^{++} : 2.0 - 2.5 GeV

The above numbers represent limits of bag model, flux-tube model, sum-rule model and lattice gauge calculations.

It should be obvious that theorists will differ. Only experiments can reveal the truth!

Quite respectable candidates for the * exotics have already emerged from BNL and LEAR, but most of the work remains to be done

There will be exciting claims and disappointing results but the search for QCD exotics is certainly

imperative & exciting

Kamal K. Seth, Northwestern University

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