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SUPERSYMMETRIC AND CONVENTIONAL SOURCES FOR
 $j\bar{e}_t$ AND $j\bar{p}_t$ EVENTS AT THE COLLIDER

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ABSTRACT

We consider the relative rates for events $j\bar{e}_t$ and $j\bar{p}_t$ at the collider. If they come from squark decays, we find a ratio $r_q = 1/10$ to $1/5$ for $m_q = 120$ to 150 GeV; if they come from standard sources, on the other hand, $r_{st} = 2/(1+\rho)$, $0 < \rho \leq 2$. Experimental cuts are taken into account. Although not very definite, the experimental situation would appear to favour conventional sources.

1. - INTRODUCTION AND CONTRIBUTION TO EVENTS FROM STANDARD SOURCES

1) Introduction

Some time ago¹⁾, we suggested that if gluinos and photinos exist and are relatively light, $m_{\tilde{g}}, m_{\tilde{\gamma}} \ll m_{\tilde{q}}$, a signal for squark production in the $p\bar{p}$ collider would be the appearance of monojets with large transverse energy E_t and large missing transverse momentum $\not{p}_t$. Later, unusual events were actually seen by the UA1²⁾ and UA2³⁾ groups, some of which were indeed monojets with much the expected characteristics^{4),5)}. In our model, the monojets were interpreted via the decay

$$\tilde{q} \rightarrow q + \tilde{\gamma};$$

another possible decay channel, $\tilde{q} \rightarrow \tilde{\chi} q'$ (where $\tilde{\chi}$ is a chargino) could ultimately lead to events $j + e/\mu + \not{p}_t$, j meaning a jet, which were apparently also seen. Although the calculation of $j\bar{p}_t$ and $je\bar{p}_t$ absolute rates suffers from large uncertainties, we argued⁶⁾ that most of them cancel in the ratio

$$r = \frac{\sum_{e/\mu \pm} \sigma(j + e/\mu + \not{p}_t)}{\sigma(j + \not{p}_t)} \quad (1.1)$$

In the present paper, we elaborate further on this point, presenting results on the differential cross-section for $je\bar{p}_t$ as well as the ratio (1.1) which take into account experimental cuts.

The experimental situation regarding potential signals for new physics has changed somewhat after the new run of the collider^{7),8)}. Many signals ($e^+e^- \gamma$, $2j$ bump,...) have become swamped by the standard physics background; and even the more characteristic type of weird events, the monojets, are now compatible with expectations from conventional sources.

In this paper we find that, for $je/\mu\bar{p}_t$ and $j\bar{p}_t$ produced via squark decays,

$$r_{\tilde{q}} = \frac{\sum_{e/\mu \pm} \sigma_{\tilde{q}}(j + e/\mu + \not{p}_t)}{\sigma_{\tilde{q}}(j + \not{p}_t)} \simeq \frac{1}{10} \text{ to } \frac{1}{5} \quad (1.2)$$

when we allow $m_{\tilde{q}}$ to vary in the range

$$120 \text{ GeV} \lesssim m_{\tilde{q}} \lesssim 150 \text{ GeV}.$$

With standard physics sources,

$$r_{st} = \frac{\sum_{e^{\pm}\mu^{\pm}} \sigma_{st} (j+e/\mu+p_t)}{\sigma_{st} (j+p_t)} \approx \frac{2}{1+\rho_{\tau}} \quad (1.3)$$

where ρ_{τ} is the ratio of τ produced monojets to Z produced monojets (for details see below), and it varies in the range $0 < \rho_{\tau} \lesssim 2$. Although the experimental situation is far from definite, the actual numbers of events look more like (1.3) than (1.2).

ii) Events from conventional sources

Monojets with large p_t ($p_t > 30 \text{ GeV}$) come mostly from two conventional sources: production of W , with the subsequent decay chain (Fig. 1a)

$$W \rightarrow \nu_{\tau} \tau \rightarrow \nu_{\tau} + q'\bar{q}, \quad (1.4)$$

which, for a luminosity $\mathcal{L} = 130 \text{ nb}^{-1}$ yields^{*)} $\sim 1,2$ monojets⁹⁾. The second conventional source is that of Fig. 2. The yield is also known^{10),11)}; it is to be noted that the theoretical calculations can be checked by comparing with the cross-section for $j e^+ e^-$ given by a process that differs from that in Fig. 2 only by the replacement of $\nu\bar{\nu}$ by $e^+ e^-$. Again, this may produce one or two monojets with $p_t > 40 \text{ GeV}$ for $\mathcal{L} = 130 \text{ nb}^{-1}$. It will be convenient to denote by $\sigma_{\tau}(j+p_t)$ and $\sigma_Z(j+p_t)$ the cross-sections for monojets produced with both types of mechanisms. Then, if we define

$$\rho_{\tau} \equiv \frac{\sigma_{\tau}(j+p_t)}{\sigma_Z(j+p_t)} \quad (1.5)$$

we see that ρ_{τ} varies between 0 and 2.

*) It would appear that, since $p_t < (\frac{1}{2})M_W$ for this mechanism, increasing the cut to $p_t > 40 \text{ GeV}$ would dispose of all τ -monojets. However, the W can acquire transverse momentum due to radiation of semihard ($E_{tg} \lesssim 10 \text{ GeV}$) gluons by the incoming quarks (Fig. 1b). See Ref. 9) for more information. It is, however, true that the number of τ -monojets decreases drastically with increasing p_t .

The conventional source of $j e^- p_t$ events is that of Fig. 3. At present collider energies, the gluon-initiated $Z+q$ (Fig. 2b) and $W+q$ (Fig. 3b) have smaller cross-sections than the $Z+g$ (Fig. 2a) and $W+g$ (Fig. 3a) ones. If we neglect them, then the ratio

$$\frac{\sigma_W(j e^- p_t)}{\sigma_Z(j p_t)}$$

can be calculated in terms only of the W,Z weak couplings. We have

$$\frac{\sigma(W+g)}{\sigma(Z+g)} = \frac{36 \cos^2 \theta_W}{45 - 108 \sin^2 \theta_W + 136 \sin^4 \theta_W} \simeq 1, \quad \sin \theta_W \simeq 1/4;$$

moreover, and for three neutrinos,

$$\begin{aligned} \frac{\Gamma(W^- \rightarrow e^- \nu)}{\Gamma(W^- \rightarrow \text{all})} &\simeq \frac{1}{12}, \\ \frac{\Gamma(Z \rightarrow \sum_{\nu} \bar{\nu} \nu)}{\Gamma(Z \rightarrow \text{all})} &= \left\{ 1 + (1 - 2 \sin^2 \theta_W)^2 + (2 \sin^2 \theta_W)^2 \right. \\ &\quad \left. + 3 \left[\left(1 - \frac{4}{3} \sin^2 \theta_W\right)^2 + \left(\frac{4}{3} \sin^2 \theta_W\right)^2 + \left(1 - \frac{2}{3} \sin^2 \theta_W\right)^2 + \left(\frac{2}{3} \sin^2 \theta_W\right)^2 \right] \right\} \simeq \frac{1}{5.3}. \end{aligned}$$

Therefore

$$r_{st} = \frac{4 \sigma_W(j e^- p_t)}{\sigma_Z(j p_t) + \sigma_Z(j p_t)} \simeq \frac{2}{1 + p_t},$$

as reported in Eq. (1.3).

In absolute numbers of events we have, with cuts taken into account,

$$\begin{aligned}
 \sigma_{\tau}^0(j+\cancel{p}_t) &\sim 1-2 \\
 \sigma_{\Sigma}^0(j+\cancel{p}_t) &\sim 1-2 \\
 \sum_{e\mu t} \sigma_W^0(j+e/\mu+\cancel{p}_t) &\sim 2-4, \quad p_t > 30
 \end{aligned}
 \tag{1.6}$$

for $\mathcal{L} = 130 \text{ nb}^{-1}$.

2. - THE SUSY FRAMEWORK

As stated in the Introduction, we will consider the case where $m_{\tilde{q}} \gg m_{\tilde{g}}, m_{\tilde{Y}}$. The situation where $m_{\tilde{q}} \sim m_{\tilde{g}}$ is discussed in Ref. 12) and work quoted there. We will not concern ourselves with this any more beyond remarking that, also in this scenario, the ratio $j\cancel{p}_t/j\cancel{\nu}_t$ coming from SUSY sources is of the same order of magnitude as in our case.

To be precise, we will consider the class of SUSY models in which the mass spectrum can be derived from supergravity-induced breaking schemes. Specifically, we will follow Ref. 13), from which we also borrow the notation. We will also assume that the top quark has a mass $m_t \sim 40 \text{ GeV}$ and will therefore take

$$\langle H_1^0 \rangle \simeq \langle H_2^0 \rangle$$

where H_1^0 are the Higgs fields of the theory. Letting $\tilde{\chi}_{h/l}$ be the heavy/light charginos and $M_{h/l}$ be their masses, we have

$$M_{h/l}^2 = \frac{1}{2} M_W^2 \left\{ \hat{M}^2 + \hat{\mu}^2 + 2 \pm \sqrt{(\hat{M}^2 - \hat{\mu}^2)^2 + 4(\hat{M}^2 \pm \hat{\mu})^2} \right\}
 \tag{2.1}$$

where

$$\hat{M} \simeq 0.81 \frac{M}{M_W}, \quad \hat{\mu} = 1.4 \frac{\mu_0}{M_W},$$

M and μ_0 being mass parameters related to the sparticle masses. The mass of the gluino is now $m_{\tilde{g}} \approx 3M$, so, because we consider light gluinos, we may simplify (2.1) to

$$M_{h/\ell}^2 \approx \frac{1}{2} M_W^2 \{ \hat{\mu}^2 + 2 \pm |\hat{\mu}|^2 \sqrt{\hat{\mu}^2 + 4} \}. \quad (2.2)$$

Note that in this case one has the relation

$$M_h M_\ell = M_W^2 \quad (2.3)$$

independently of the value of $\hat{\mu}$. This means that, of necessity, $M_\ell < M_h$.

If the gluinos are light, existing experimental evidence forces the squarks to have masses upwards of 80-100 GeV. Therefore, at least the decay

$$\tilde{q} \rightarrow q + \tilde{\chi}_\ell \quad (2.4)$$

will always be possible: we have identified the main squark sources of monojets and at least one source of $j\bar{p}_t$ events:

$$\begin{aligned} \tilde{q} &\rightarrow q + \tilde{\gamma} \\ \tilde{q} &\rightarrow q' + \tilde{\chi}_\ell \\ &\quad \rightarrow e + \tilde{\gamma}. \end{aligned}$$

We may, however, go further. The number of monojet events^{2),8)} would make us conclude that $m_{\tilde{q}} \gtrsim 120$ GeV. If, moreover, we accept the experimental indications¹⁴⁾ that $M_\ell > 60$ GeV, Eq. (2.3) gives $M_h < m_{\tilde{q}}$ and thus the decay

$$\tilde{q} \rightarrow q + \tilde{\chi}_h \quad (2.5)$$

also becomes possible, yielding another source of $j\bar{p}_t$ events.

The elementary couplings of $\tilde{q}q'\tilde{\chi}$, etc., are given, for example, in Ref. 15). They involve standard constants, α_s , α , $\alpha_w = \alpha/\sin^2\theta_w$ and an angle ϕ in such a way that couplings of $\tilde{\chi}_\ell$ are proportional to $\sin\phi$ and those of $\tilde{\chi}_h$ go with $\cos\phi$. In the approximation $\langle H_1^0 \rangle \approx \langle H_2^0 \rangle$, $M \sim 0$, ϕ is given in terms of masses by

$$\cos \phi = \left(1 + \frac{M_{\tilde{e}}^2}{M_W^2} \right)^{-1/2}$$

Finally, to be consistent with the lack of a large number of gluino monojets^{16),4),5)}, we take

$$m_{\tilde{g}} \lesssim 10 \text{ GeV}$$

and therefore

$$m_{\tilde{\gamma}} \sim \frac{1}{7} m_{\tilde{g}} \lesssim 1.5 \text{ GeV}.$$

3. - ABSOLUTE BRANCHING RATIOS FROM SUSY SOURCES

In this section we calculate the branching ratio

$$B(je^{-}p_t) = \frac{\Gamma(\tilde{q} \rightarrow e^{-}q'\nu\tilde{q})}{\Gamma(\tilde{q} \rightarrow q\tilde{q})} \quad (3.1)$$

without experimental cuts. In our SUSY scenario, the processes in (3.1) are the dominant contributions to both $je^{-}p_t$ and $j\cancel{p}_t$ signals, so that

$$r_{\tilde{q}} \simeq \sum_{\ell=e^{\pm}, \mu^{\pm}} B(j\ell\cancel{p}_t) = 4 B(je^{-}p_t). \quad (3.2)$$

The relevant decays are given in Eqs. (2.4) (see Fig. 4) and (2.5) (Fig. 5). In the first case, the $\tilde{\chi}_h$ will decay mostly into $W+\tilde{\gamma}$, with the W going into $\bar{f}f'$ pairs. Thus, for the desired signal, we have to consider

$$\frac{\Gamma(W^{-} \rightarrow e^{-}\nu)}{\Gamma(W^{-} \rightarrow \text{all})} \simeq \frac{1}{12}$$

and the $\tilde{\chi}_h$ contribution to B, $B_{\tilde{\chi}_h}$ is found to be

$$\begin{aligned}
 B_{\tilde{\chi}_h}(je^{-p_t}) &= \frac{1}{12} \cdot \frac{\Gamma(\tilde{q} \rightarrow q' \tilde{\chi}_h)}{\Gamma(\tilde{q} \rightarrow q \tilde{q})} \\
 &= \frac{\cos^2 \phi}{32 \sin^2 \theta_W} \left(1 - M_h^2/m_{\tilde{q}}^2\right)^2.
 \end{aligned} \tag{3.3}$$

In the second case, the $\tilde{\chi}_\ell$ will decay according to the diagrams of Fig. 5b. The rates for general values of the masses may be found in Ref. 17); for our scenario, we can work in the approximation

$$\left| \frac{M_W - M_\ell}{M_W} \right| \ll 1, \quad \left(\frac{M_\ell}{m_{\tilde{q}}, m_{\tilde{\ell}}} \right) \ll 1.$$

In this case, slepton-mediated decays give a negligible contribution and we find

$$\begin{aligned}
 \Gamma(\tilde{\chi}_\ell \xrightarrow{\tilde{q}} \tilde{q} \bar{q} q') \\
 = (\sin^2 \phi) M_\ell \frac{\alpha_s \alpha}{8\pi \sin^2 \theta_W} \left(\frac{M_\ell}{m_{\tilde{q}}} \right)^4 A(m_{\tilde{q}}/M_\ell),
 \end{aligned} \tag{3.4a}$$

$$\begin{aligned}
 \Gamma(\tilde{\chi}_\ell \xrightarrow{W} \bar{f} f' \tilde{q}) \\
 = (\sin^2 \phi) M_\ell \frac{\alpha^2}{2\pi \sin^2 \theta_W} B(M_W/M_\ell),
 \end{aligned} \tag{3.4b}$$

where

$$\begin{aligned}
 A(\rho) &\equiv 12 \rho^4 \int_0^1 dx \frac{x(1-x)^2}{(\rho^2 - x)^2} \xrightarrow{\rho \rightarrow \infty} 1, \\
 B(\lambda) &\equiv \int_0^1 dx \frac{(x+1/2)(1-x)^2}{(\lambda^2 - x)^2} \xrightarrow{\lambda \rightarrow 1} 1.
 \end{aligned}$$

Using the result

$$\frac{\Gamma(\tilde{q} \rightarrow q' \tilde{\chi}_\ell)}{\Gamma(\tilde{q} \rightarrow q \tilde{\chi})} = \frac{3 \sin^2 \phi}{8 \sin^2 \theta_W} \left(1 - \frac{M_\ell^2}{m_{\tilde{q}}^2}\right)^2,$$

we finally obtain

$$B_{\tilde{\chi}_\ell}(je^- p_t) = \frac{\sin^2 \phi}{32 \sin^2 \theta_W} \left(1 - \frac{M_\ell^2}{m_{\tilde{q}}^2}\right)^2 \times \left\{1 + \frac{A}{B} \cdot \frac{\alpha_s}{4\alpha} \cdot \left(\frac{M_\ell}{m_{\tilde{q}}}\right)^4\right\}^{-1}. \quad (3.5)$$

For example, for the values

$$m_{\tilde{q}} = 120 \text{ GeV}, \quad M_{\tilde{\chi}_\ell} = 64 \text{ GeV}, \quad M_{\tilde{\chi}_h} = 105 \text{ GeV}, \quad \cos^2 \phi = 0.62,$$

$$B_{\tilde{\chi}_h}(je^- p_t) = 0.005, \quad B_{\tilde{\chi}_\ell}(je^- p_t) = 0.02 \quad (3.6a)$$

from which

$$r_{\tilde{q}} \simeq \frac{1}{10} \quad (3.6b)$$

For $m_{\tilde{q}} = 150$ and the rest as before,

$$B_{\tilde{\chi}_h}(je^- p_t) = 0.023, \quad B_{\tilde{\chi}_\ell}(je^- p_t) = 0.032, \quad (3.7a)$$

so that

$$r_{\tilde{q}} \simeq \frac{1}{5}. \quad (3.7b)$$

4. - DIFFERENTIAL CROSS-SECTIONS AND RATES WITH CUTS

In order to compare theoretical results for r or any other similar quantity with experiment, cuts have to be imposed. Indeed, a realistic simulation of the experimental situation (including things such as acceptances of experimental apparatus) should be performed. It is our belief that this job should be carried out by the experimentalists themselves; however, to get an idea of the influence of cuts, we have performed the analysis of r for a set of typical cuts. Those on $j p_t$ events were already calculated in Ref. 6), of which we take over the result. The cuts on $j e p_t$ are estimated by a detailed calculation of the $\tilde{\chi}_h$ channel. Cuts suppress events in such a way that there is a reduction by a factor ~ 2 to 3. Since the reduction for numerator and denominator in r are similar to within 50%, the figures quoted in the Introduction for the total rates are valid to this error for rates of observed events.

Now we pass to the details. We may write the cross-sections as

$$\begin{aligned} \sigma_{h/\ell}(j e^- p_t) &= \int_0^1 dx_1 \int_0^1 dx_2 \sigma_{\tilde{q}}(x_1, x_2; m_{\tilde{q}}^2) \\ &\times \frac{\Gamma(\tilde{q} \xrightarrow{\tilde{\chi}_{h/\ell}} e^- q' \tilde{g} \bar{\nu})}{\Gamma(\tilde{q} \rightarrow \text{all})} q(x_1) \tilde{g}(x_2) \delta(m_{\tilde{q}}^2 - x_1 x_2 s) \\ &+ (q \leftrightarrow \tilde{g}), \end{aligned} \quad (4.1)$$

where q and $\tilde{g}$ are the quark and gluino distribution functions^{1),5),18),19)}; $\sigma_{\tilde{q}}$ is the cross-section for the elementary process $\tilde{g}+q \rightarrow \tilde{q}$, with $\tilde{g}$, q having momenta $x_1 p_p$, $x_1 p_p^-$ respectively:

$$\sigma_{\tilde{q}} = \frac{\pi^2 \alpha_s}{m_{\tilde{q}}^2 n_c} x_1 x_2 s, \quad n_c = 3, \quad s = (p_p + p_p^-)^2;$$

finally $\Gamma(\tilde{q} \rightarrow \text{all})$ is, to a good approximation, given by

$$\Gamma(\tilde{q} \rightarrow \text{all}) \simeq \Gamma(\tilde{q} \rightarrow q \tilde{g}) = \frac{1}{2} C_F \alpha_s m_{\tilde{q}}, \quad C_F = 4/3.$$

The differential cross-section is

$$d\sigma(j e^- p_t) = d\sigma_h + d\sigma_\ell,$$

$$d\sigma_{h/\ell} (j e^- p_t) = \frac{\pi^2 \alpha_s}{m_{\tilde{q}}^2 n_c} \cdot \frac{1}{\Gamma(\tilde{q} \rightarrow \text{all})} \\ \times \int_0^1 \frac{dx}{x} F_q(x) F_{\tilde{g}}\left(\frac{p}{x}\right) d\Gamma(\tilde{q} \xrightarrow{\tilde{\chi}_{h/\ell}} q' e^- \tilde{\gamma} \bar{\nu}) \quad (4.2)$$

with $F_q = q(x) x$, $F_{\tilde{g}} = \tilde{g}(x) x$ the structure functions of quarks, gluinos inside protons and $\rho = m_q^2/s$. Moreover,

$$d\Gamma(\tilde{q} \xrightarrow{\tilde{\chi}_{h/\ell}} q' e^- \tilde{\gamma} \bar{\nu}) \\ = \frac{|F_{h/\ell}|^2}{4\pi Q^0} d\Phi_{h/\ell}; \quad (4.3)$$

$$d\Phi_h = \delta_4(Q - q - k - p_1 - p) \delta(K^2 - M_w^2) \delta(P^2 - M_h^2) \\ \times \frac{d\vec{q}}{2q^0} \frac{d\vec{p}_1}{2p_1^0} \frac{d\vec{p}}{2p^0} \frac{d\vec{k}}{2k^0}, \quad (4.4a)$$

$$d\Phi_\ell = \delta_4(Q - q - k - p_1 - p) \delta(P^2 - M_\ell^2) \\ \times \frac{d\vec{q}}{2q^0} \frac{d\vec{p}_1}{2p_1^0} \frac{d\vec{p}}{2p^0} \frac{d\vec{k}}{2k^0}; \quad (4.4b)$$

$$|F_h|^2 = \frac{16 \alpha \alpha_w^2 \cos^2 \phi}{(2\pi)^2 \Gamma_w \Gamma_{\tilde{\chi}_h} M_w M_h} T_h, \quad (4.5a)$$

$$|F_\ell|^2 = \frac{32 \alpha \alpha_w^2 \sin^2 \phi}{(2\pi)^3 \tilde{\chi}_\ell M_\ell (K^2 - M_W^2)} \cdot \frac{\Gamma_\ell}{1 + \frac{\alpha_s A}{4\alpha B} \left(\frac{M_\ell}{m_{\tilde{q}}}\right)^4}, \quad (4.5b)$$

with A, B as in Eqs. (3.4) and (3.5). Finally,

$$\Gamma_W = \alpha_w M_W, \quad \Gamma_{\tilde{\chi}_h} = \frac{\alpha}{4} \cdot \frac{(M_h^2 - M_W^2)^2}{M_h^3} \left(1 + \frac{M_h^2 + M_W^2}{M_W^2}\right), \dots \text{ and}$$

$$\Gamma_{h/\ell} = m_{\tilde{q}}^2 \left[(p \cdot p_1)(q \cdot Q) - (p \cdot p_1)(q \cdot k) \right] \\ - M_{h/\ell} \left[(p \cdot p_1)(q \cdot Q) - (p \cdot q)(k \cdot p_1) \right].$$

The variables Q, p, ... are defined in Fig. 6. Taking the OZ axis along $\vec{Q}$, we can express the momenta $\vec{p}, \vec{k}, \dots$ in polar co-ordinates:

$$\vec{k} = k^0 (s_k \cos \varphi_k, s_k \sin \varphi_k, c_k) \\ \vec{q} = q^0 (s_q \cos \varphi_q, s_q \sin \varphi_q, c_q) \\ \vec{p}_1 = p_1^0 (s_1 \cos \varphi_1, s_1 \sin \varphi_1, c_1) \\ \vec{p} = p^0 (s_p \cos \varphi_p, s_p \sin \varphi_p, c_p); \\ c_{kq} \equiv \cos \theta_{kq} = \vec{k} \cdot \vec{q} / k^0 q^0,$$

where $s_k = \sin \theta_k$, $c_k = \cos \theta_k$, etc.

We have made a numerical analysis for the case of squark decay via $\tilde{\chi}_h$ which should suffice to give a rough idea of the effect of cuts. Integrating as many unobservable variables as is possible without undue effort, we arrive at the expression

$$\begin{aligned}
 \Gamma(\tilde{q} \xrightarrow{\tilde{\chi}_h} q' e^{-\tilde{\gamma}} \bar{\nu}) &= 2^{-6} \frac{1}{4\pi} \int_{\text{Cuts}} dc_q dq_q dc_k dc_l dc_{kq} dq^0 \\
 &\times \frac{k^0 |F_h|^2}{Q^0 [Q^0 - |\vec{Q}| c_k] |\sin \varphi_1 \sin \varphi_k s_1 s_k s_q^2|} \cdot \left| p^0 + q^0 + p_1^0 - |\vec{Q}| c_1 \right. \\
 &\left. + k^0 \left\{ c_1 c_k + \frac{s_k \cos \varphi_k}{s_q} (1 - c_1 c_q) + \frac{s_k \sin \varphi_k}{2 s_1 s_q^2 \sin \varphi_1} \left[\frac{M_W^2 (1 - c_1 c_q)}{p_1^0 q^0} - 2 (c_1 - c_q)^2 \right] \right\} \right|^{-1}
 \end{aligned}
 \tag{4.8}$$

Finally, the total number of events will be

$$N_{h/l}(je^{-\chi_t}) = \mathcal{L} \sigma_{h/l}.$$

For this calculation we took

$$\mathcal{L} = 130 \text{ nb}^{-1}, \quad s = (630 \text{ GeV})^2.$$

The resulting numbers for σ_h are summarized in the Table. The cuts we took were

$$30^\circ \leq \theta_k, \theta_q \leq 150^\circ,$$

$$40^\circ \leq \theta_{kq} \leq 180^\circ$$

$$k_t \geq 25 \text{ GeV}, \quad q_t \geq 15 \text{ GeV}, \quad \chi_t \geq 25 \text{ GeV}.$$

Here k_t, q_t are the projections of $\vec{k}, \vec{q}$ on the plane orthogonal to the beam axis.

We see that cuts suppress the signal by a factor 2 to 3. Since to a degree of about 50% the same suppression affects monojets¹⁶⁾, we conclude that, to this precision, the estimates (1.2) still hold.

5. - CONCLUSIONS

The experimental evidence is so scanty that, until larger statistics are collected, we cannot draw clear-cut conclusions; of necessity we will have to present tentative comments on comparisons between theory and experiment.

There are two possibilities if we assume that the $j\bar{e}/\mu\bar{p}_t$ events found in the old run^{2),3)} are typical and not merely statistical flukes. Then we have, for $\mathcal{L} = 130 \text{ nb}^{-1}$, $s = (540 \text{ GeV})^2$,

$$\sigma^P(j\bar{e}/\mu\bar{p}_t) \sim 1.5. \quad (5.1)$$

Now:

- i) If they are due to standard sources, with which the number (5.1) is indeed well compatible, we expect

$$\sigma^P(j\bar{p}_t) \sim 0.5 \text{ to } 3,$$

not in contradiction with the reported numbers ($\sigma^P = 5$ by UA1, $\sigma^P = 0$ by UA2).

- ii) If the $j\bar{e}/\mu\bar{p}_t$ are due to squark decay, we expect

$$\sigma^P(j\bar{p}_t) \sim 5 \text{ to } 20$$

in the light gluino scenario, and not very different numbers in the $m_{\tilde{g}} > m_{\tilde{q}}$ one. Clearly, and although we cannot exclude that some of the $j\bar{p}_t$, $j\bar{e}/\mu\bar{p}_t$ events are SUSY signals, the interpretation in terms of standard physics is consistent with data and, indeed, favoured by it; even more so if we take into account more recent experimental indications.

m_q (GeV)	N_h	
	Without cuts	With cuts given in text
130	0.75	$\lesssim 0.2$
135	0.93	0.27
140	1.16	0.48
150	0.91	0.58

Table

Number of je^-p_t events. $M_\lambda = 64$ GeV, $M_h = 105$ GeV.
 $s = (630 \text{ GeV})^2$, $\mathcal{L} = 130 \text{ nb}^{-1}$.

REFERENCES

- 1) M.J. Herrero et al., Phys. Lett. 132B (1983) 199.
- 2) G. Arnison et al., Phys. Lett. 139B (1984) 115.
- 3) P. Bagnaia et al., Phys. Lett. 139B (1984) 105.
- 4) A. De Rujula and R. Petronzio, CERN preprint TH.4070/84 (1984).
- 5) R.M. Barnett, H.E. Haber and G.L. Kane, Phys. Rev. Lett. 54 (1985) 1983.
- 6) M.J. Herrero et al., Phys. Lett. 145B (1984) 430.
- 7) H. Hänni, St. Vincent Workshop on Collider Physics, CERN preprint EP/85-87 (1985).
- 8) M. Mohammadi, Aspen Conference on Collider Physics, CERN preprint EP/85-52 (1985).
- 9) R. Odorico, Bologna preprint IFUB 85/1 (1985).
- 10) G. Altarelli, R.K. Ellis and G. Martinelli, CERN preprint TH.4015/84 (1984).
- 11) S. Geer and W.J. Stirling, CERN preprint TH.4063/84 (1984);
S.D. Ellis, R. Kleiss and W.J. Stirling, CERN preprint TH.4185/85 (1985);
J.R. Cudell, F. Halzen and K. Hiraka, Madison preprint MAD/PH/237 (1985).
- 12) H. Baer et al., Phys. Lett. 153B (1985) 265.
- 13) L.E. Ibañez, C. Lopez and C. Muñoz, CERN preprint TH.4071 (1985).
- 14) C. Rubbia, talk given at the St. Vincent Workshop on Collider Physics (1985).
- 15) H.E. Haber and G.L. Kane, Physics Reports 117C (1985) 75.
- 16) J. Ellis and H. Kowalski, CERN preprint TH.4126/85 (1985).
G. Altarelli, B. Mele and S. Petrarca, Rome preprint No. 470 (1985).
- 17) G. Altarelli, B. Mele and S. Petrarca, CERN preprint TH.3822/84 (1984).
- 18) V. Barger et al., Madison preprint MAD/PH/232 (1985).
- 19) B.A. Campbell, J. Ellis and S. Rudaz, Nucl. Phys. B198 (1982) 1;
C. Kounnas and D.A. Ross, Nucl. Phys. B214 (1983) 317;
S.K. Jones and C.H. Llewellyn Smith, Nucl. Phys. B217 (1983) 145;
M.J. Herrero, C. Lopez and F.J. Yndurain, Nucl. Phys. B244 (1984) 207.

FIGURE CAPTIONS

Fig. 1 : Production of τ monojets.

Fig. 2 : Production of Z monojets.

Fig. 3 : Production of W je^-p_t events.

Fig. 4 : Production of $\tilde{\chi}_h$ -mediated je^-p_t events from $\tilde{q}$ decay.

Fig. 5 : Production of $\tilde{\chi}_\rho$ -mediated squark decays.

Fig. 6 : The full $\tilde{q}$ -mediated $p\bar{p}$ production of je^-p_t .

(a)

(b)

Fig. 1

(a)

(b)

Fig. 2

(a)

(b)

Fig. 3

Fig. 4

(a)

(b)

Fig. 5

Fig. 6