MULTY FACE UNITY

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We studied fine structure of objects:

1. The star formation regions: Orion KL, W 3 OH
2. The nearest objects – whirlwinds.
3. The active nucleus of galaxies: 3C 84, 3C 273, M 87, 3C 454.3, Cyg A, 1803+784, NGC 4258

The structures and kinematics are similar.
Disk S-form, $\phi \sim 30$ AU visible of the edge

Compact components are tangential direction of arms.

The disk rigid body rotation, $T_{rot} \approx 170$ yr

Bipolar outflow

$R \geq 7$ AU

Keplerian movement

$M < 0.01$ $M_{\odot}$

ORION KL – $H_2O$ Mega maser emission, $0.5$ AU/mas
Low velocity nozzle
$\phi = 0.45 \text{ AU}, \ T_b \approx 10^{13} \text{ K}$

High velocity ejector
$T_b = 10^{17} \text{ K}$

• Helix structure
  Precession period $T \sim 10 \text{ yr}$
  Precession angle $\sim 16^\circ$
BIPOLAR OUTFLOW

LOW & HIGH velocity jets

Φ = 0.34 AU
Orion KL
The bipolar outflow
Epoch 1998 yr.

* The collimation and acceleration - interaction with surrounding medium.
* Ejection velocity $v \sim 5$ km/s
* An acceleration $\Rightarrow v \geq 40$ km/s at 2 AU.
Whirlwind

*High & low velocity jet*
Conclusion.

Movement of matter – unstable  => formation of whirlwind – anti centrifuge:

• Surrounding matter is accreting to “disk” and flowing along arm to a center.
• An extra angular momentum carries of by rotated bipolar outflow.
• “The disk” - rigid body rotation.
• The acceleration and collimation of the outflow – interaction with surrounding matter.
• A surplus of the matter is falling at the forming central body.
• Gravity field of the body stabilized the process.
Galaxy

Keplerian and rigid body rotation disk
Bipolar outflow
NGC 4258  \( H_2O \) maser radiation, (Moran et al., 1995)

**rigid body rotation, \( \dot{\psi} = 8000 \text{ km/s/pc} \)**

Keplerian

V rot (R = 0.28 pc) = 770 km/s, V rot (r = 0.14 pc) = 1080 km/s, M = \( 10^7 \) M\(_{\odot} \)

Keplerian
High and low velocity bipolar outflow.
The jet >> the counter jet
Velocity of fragments

\[ V_{\text{vis}} \sim 8c \]

\[ V_{\text{vis}} \leq 0.06c \]

3C 345 \( \lambda = 7 \text{ mm} \)
3C 345, $\lambda=7$ mm.

The brightness of bipolar outflow

$T_{\text{peak}} \approx 50 \cdot 10^{12}$ K, $\lambda=2$ cm

Counterjet  

jet  

emission of ejected relativistic electrons

“post emission”
M 87 – radio galaxy, 0.078 pc/mas

Bipolar outflow

High & Low velocity bipolar outflows. Horn – decreasing $\phi$ of nozzle
**M 87** brightness of bipolar outflow, $\lambda=2$ cm

$T_b \approx 2 \times 10^{12}$ K

*Counterjet & jet – emission of ejected relativistic electrons*

*Jet – “post emission” of accelerated electrons*
High & low velocity bipolar outflow

\[ T_b \approx 20 \times 10^{12} \text{ K}, \ \lambda = 7 \text{ mm (0.02)}; \ 18 \text{ cm (0.1 mas)} \]

\[ \phi_{\text{nozzle}} = 0.2 \Rightarrow 20 \text{ pc} \]
**3C 454.3**

7.7 pc/mas

**Disk**

High & low velocity outflow

$T_b \geq 50 \times 10^{12}$ K

$\lambda = 7$ mm $\phi = 0.010$ mas

$\lambda = 2.5$ cm

$\lambda = 7$ mm, 2.5 $\mu$as

arms
3C 273  2.7 pc/mas  \( \lambda = 2 \text{ cm} \)

**Bipolar outflow**

1. The high velocity jet & counterjet \( \leq 3 \text{ pc.} \)
2. The low velocity jet – chains of components
3. The nozzle brightness \( T_b = 40 \cdot 10^{12} \text{K}, \varphi = 20 \text{ \mu as.} \)
4. The jet velocity \( v < 0.03c. \)
**Cyg A**, 1 pc/mas

*Bipolar outflow*

*High & low velocity*

\[ T_b \approx 4 \times 10^{12} \text{ K} \]

B. Boccardi, 
T. Krichbaum...7 mm.

\[ \lambda = 2 \text{ cm} \]
3C 84 0.35 pc/mas

Double system $\Delta V \approx 600$ km/s, $T \approx 5 \cdot 10^3$ yr

$\lambda = 2$ cm

$\lambda = 7$ mm

$T_b \approx 50 \times 10^{12}$ K
## Parameters of AGN

<table>
<thead>
<tr>
<th>Sources</th>
<th>$T_b \times 10^{12}$ K</th>
<th>$\phi_o$, pc</th>
<th>$\phi_{1/2}$ pc</th>
<th>$V_c$</th>
<th>$L_{jet} - L_{ejet}$</th>
<th>$L_{jet}/L_{ejet}$</th>
<th>D, Mpc</th>
<th>pc/mas</th>
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</thead>
<tbody>
<tr>
<td>3C84</td>
<td>50/(\lambda=2) cm</td>
<td>0.007</td>
<td>0.3/0.8/1.4</td>
<td>-</td>
<td>1.1/0.3</td>
<td>3.5</td>
<td>75</td>
<td>0.35</td>
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<tr>
<td>3C273</td>
<td>45/2</td>
<td>0.05</td>
<td>2.2/6</td>
<td>0.06</td>
<td>16/3.2</td>
<td>5</td>
<td>735</td>
<td>2.7</td>
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<tr>
<td>M87</td>
<td>10/6</td>
<td>0.004</td>
<td>0.07/0.12/0.8</td>
<td>0.02</td>
<td>0.24/0.01</td>
<td>2.4</td>
<td>16.75</td>
<td>0.078</td>
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<tr>
<td>3C454.3</td>
<td>150/0.7</td>
<td>0.003</td>
<td>14/40</td>
<td>-</td>
<td>20/8 -</td>
<td>3</td>
<td>5489</td>
<td>7.7</td>
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<tr>
<td>3C345</td>
<td>50/2</td>
<td>$\leq 0.07$</td>
<td>1.3/2.1</td>
<td>0.05</td>
<td>5.6/0.8</td>
<td>7</td>
<td>3473</td>
<td>6.63</td>
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<tr>
<td>Cyg A</td>
<td>4/(\lambda=2) cm</td>
<td>$\leq 0.02$</td>
<td>0.65/1.6</td>
<td>-</td>
<td>3.5/0.8</td>
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<tr>
<td>1803+784</td>
<td>20/0.7</td>
<td>0.06</td>
<td>1.4/2.5/5</td>
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<td>3.5/13-</td>
<td>4</td>
<td>4107</td>
<td>7.06</td>
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<tr>
<td>medium</td>
<td>4 -150</td>
<td>0.01 – 0.05</td>
<td>$\leq 5$</td>
<td>$&lt;0/05$</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Conclusion

• AGN – whirlwind – space tornado.
• Electro conducting medium.
• Rotate flowers – generation current/magnetic field
• Magnetic fields – extra acceleration and collimation.
• Ring currents - jet solenoids, “disk” dipole.
• The jet & counterjet - moving along & opposite of the magnetic field of system – acceleration and deceleration.
• The nozzle - ejector of the relativistic electrons $T_b > 10^{12} \, \text{K}$.

• Dedicate to 55yr VLBI & 22yr VLBA

THANKS
Trajectory of the Zond – Venus atmosphere.
Distance $100 \cdot 10^6$ km. $\lambda=18$ cm. Accuracy 100 m (0.2 mas).
Fringe size $\varphi=5$ mas ($B=8 \times 10^3$ km)