CIRCUMBINARY DISKS

1. ARE THEY GRAVITATIONALLY BOUND?

2. WHAT ARE THEY MADE OF?

3. HOW DID THEY GET THERE?

4. WHAT DO THEY DO?

EXAMPLES: RED RECTANGLE, BM Gem, 89 Her, SS Lep ...

AC Her, POSTER BY BILLER ET AL. (ARIZONA MID-IR A/O)

MID-IR SIZE SMALLER THAN $\sim$ 0.3”

PROBABLY SUPERSEDES KECK REPORT OF RESOLVED IMAGE

STRENGTHENS CASE FOR CIRCUMBINARY DISK

WATERS ET AL. 1993 PROPOSED ORBITING DISK FOR 89 Her

m_V = 5.47 mag, F2

WARM INFRARED EXCESS, $F_\nu(12\ \mu m) = 98$ Jy, $F_\nu(25\ \mu m) = 54$ Jy

288 DAY PERIOD, $K = 3.1$ km s^{-1}, $e = 0.19$

NARROW (8 KM s^{-1}) CO LINE

PROTOTYPE: RED RECTANGLE (B-A GIANT, $m_V = 9.0$ mag)

SINGLE-LINED SPECTROSCOPIC BINARY

318 DAY PERIOD, $e = 0.37$

$K = 13.0$ km s^{-1}

$D = 330$ pc - 710 pc

$L = 1300$ L$_\odot$ - 6000 L$_\odot$

POST MAIN SEQUENCE:

CARBON ISOTOPE RATIO

$^{12}CO/^{13}CO$ = **2.2**

ATMOSPHERIC COMPOSITION:

$[Fe]/[H]$ = **-3.3 (2000 BELOW SUN)**

$[ZN]/[H]$ = **-0.6 (4 BELOW SUN)**

PROMINENT CIRCUMSTELLAR MATTER

INFRARED EXCESS, PAH EMISSION

OPTICAL NEBULOSITY

CIRCUMSTELLAR CO

PECULIAR ULTRAVIOLET EXTINCTION

EVIDENCE FOR A DISK:

MORPHOLOGY

KINEMATICS, MAPS OF CO

O-RICH + C-RICH COMPOSITION

cm-WAVELENGTH DUST EMISSION

DISK DUST MASS = 3 $\times$ 10^{-3} $M_\odot$

DUST/GAS RATIO UNCERTAIN, COULD BE AS HIGH AS 1

BINARY ANGULAR MOMENTUM
BINARY $\sim$ 10^{54} g cm s^{-2}

DISK ANGULAR MOMENTUM $\sim$
$M_{disk}\ (G\,M_*\,D_{out})^{1/2}$

M_{disk} < 0.3 $M_\odot$?

FORMATION OF DISK:

ROTATING STAR LOSES MATTER

STAYS GRAVITATIONALLY BOUND TO SYSTEM

EVOLUTION OF DISK

TORQUE ON DISK BY BINARY

OUTWARD FLOW OF ANGULAR MOMENTUM

MIGHT GROW TO 1000 AU

DISK WIND:

MATERIAL VERTICAL TO THE DISK

UNBOUND TO RADIATION PRESSURE IF RADIUS < 0.01 cm

COMPLEX MATERIAL RETURNED TO INTERSTELLAR MEDIUM

EFFECTS OF DISK

PRODUCE CARRIER OF DIFFUSE INTERSTELLAR BANDS?

GROWTH OF PARTICLES INTO MACROSCOPIC OBJECTS?

CONCLUSIONS

1. GRAVITATIONALLY BOUND CIRCUMBINARY DISKS EXIST

2. UP TO 0.003 $M_\odot$ SOLIDS

3. IMPORTANT ANGULAR MOMENTUM BUDGET

4. PRODUCE COMPLEX MATERIALS