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STS-3 "SNOWFLAKE" STUDY

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# STS-3 "SNOW FLAKE" STUDY

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**SHUTTLE ENVIRONMENT WORKSHOP**

**JET PROPULSION LABORATORY  
PASADENA, CALIFORNIA**

## BACKGROUND

- DURING STS-3 MISSION A SIGNIFICANT NUMBER OF PARTICLES WERE OBSERVED BEING RELEASED FROM THE ORBITER
- VIDEOTAPE RECORDINGS WERE MADE ON DAYS (MET) 3 AND 7
- USAF/SD (Y00R) FUNDED REDUCTION OF THIS DATA TO OBTAIN SOURCES AND SIZES
- JPL IMAGE PROCESSING LAB REDUCED VIDEOTAPES

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## APPROACH

- BASIC DATA - VIDEOTAPE FORWARD BAY TV CAMERAS
- ORIENTATION
  - CAMERA VIEW AFT
  - ORBITER TAIL TO SUN (  $\perp$  PLANE OF PHOTOS)
  - ORBITER VELOCITY +Y (LEFTWARD IN PHOTOS)
- APPARENT PARTICLE SIZE, IN-PLANE VELOCITY  
BY IMAGE PROCESSING TECHNIQUES
- WORST CASE SCALING  
BY OBJECTS OF KNOWN DIMENSION IN PHOTO AND ASSUMPTION  
X-LOCATION AT ORBITER TAIL
- DETERMINISTIC PARTICLE SIZE AND X-LOCATION  
BY ANALYSIS OF APPARENT Y-ACCELERATION ON THE BASIS OF DRAG
- DETERMINISTIC PARTICLE X-VELOCITY  
BY ANALYSIS OF APPARENT Z-ACCELERATION ON THE BASIS OF CONSTANT  
X-VELOCITY (ALSO USED TO CORRECT Y-ACCELERATION)

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## CATALOGUED PARTICLE SUMMARY

- DETERMINANT PARTICLES

SIZE RANGE: 0.11 cm TO 0.72 cm

SPEED IN Y-Z PLANE: 0.5 cm/s TO 4 cm/s

VELOCITY X-COMPONENT: 2 cm/s TO 98 cm/s

SENSE OF VELOCITY:  $V_Z > 0$ ,  $V_Y < 0$  (USUALLY)

$V_X > 0$ , (WITH ONE EXCEPTION)

X-COORDINATE RANGE

FROM CAMERA AND AFT: 350 cm TO 1100 cm

IN STS COORDINATES: 714 TO 1009 (in.)

## CATALOGUED PARTICLE SUMMARY (contd)

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- INDETERMINANT PARTICLES (WORST CASE\*)

SIZE RANGE: 0.85 cm TO 2.6 cm

SPEED IN Y-Z PLANE: 6 cm/s TO 21 cm/s

VELOCITY X-COMPONENT: 175 cm/s TO 980 cm/s

SENSE OF VELOCITY:  $V_Z > 0, V_Y < 0$  (USUALLY)

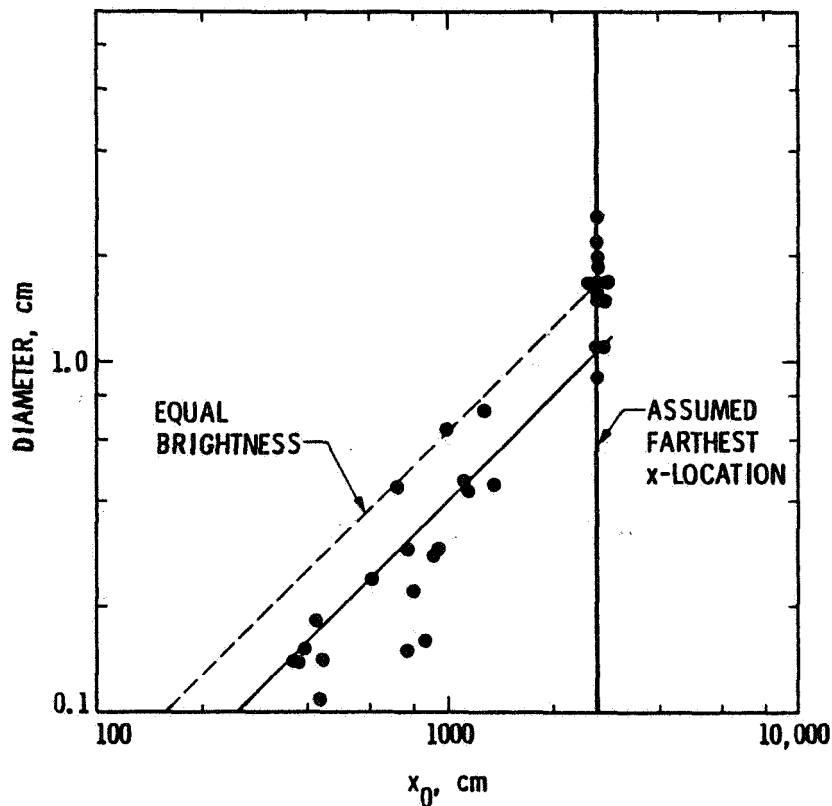
$V_X > 0$  (WITH TWO EXCEPTIONS)

\*X-COORDINATE (ASSUMED MAX)

FROM CAMERA AND AFT: 2670 cm

IN STS COORDINATES: 1627 (in.)

## CATALOGUED PARTICLES



## TYPICAL PARTICLE SIZE DISTRIBUTION

### UNCATALOGUED PARTICLES WORST CASE SIZE SCALING

<u>APPROX FOV *</u> <u>(degrees)</u>	<u>MIN PARTICLE</u> <u>(cm)</u>	<u>MAX PARTICLE</u> <u>(cm)</u>	<u>SIZE GROUP</u> <u>(cm)</u>	<u>NUMBER OF*</u> <u>PARTICLES</u>
3	0.5	2.6	0.5-1.1	21
			1.1-1.6	18
			1.6-1.9	16
			1.9-2.2	7
			> 2.2	3
				<hr/> 65 TOTAL

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\*FIELD OF VIEW EXAMINED. NOT FOV OF CAMERA. NUMBER UNDERESTIMATED.  
SMALLER (DIMMER) PARTICLES ARE ESPECIALLY UNDER-REPRESENTED

## CONCLUSIONS

- SIGNIFICANT NUMBER OF 1 mm TO 1 cm DIAMETER PARTICLES IN VICINITY OF STS-3 OBSERVED
- ORIGIN MAY BE NEAR AFT END OF ORBITER BUT FOR EXAMINED TRAJECTORIES (33) OVER HALF (19) WERE DEFINITELY FORWARD OF THE AFT END OF THE BAY
- THERE MAY BE LARGER PARTICLES NEAR AFT END OF ORBITER
- MOST PARTICLES MOVING GENERALLY REARWARD WITH RESPECT TO ORBITER (+X DIRECTION)