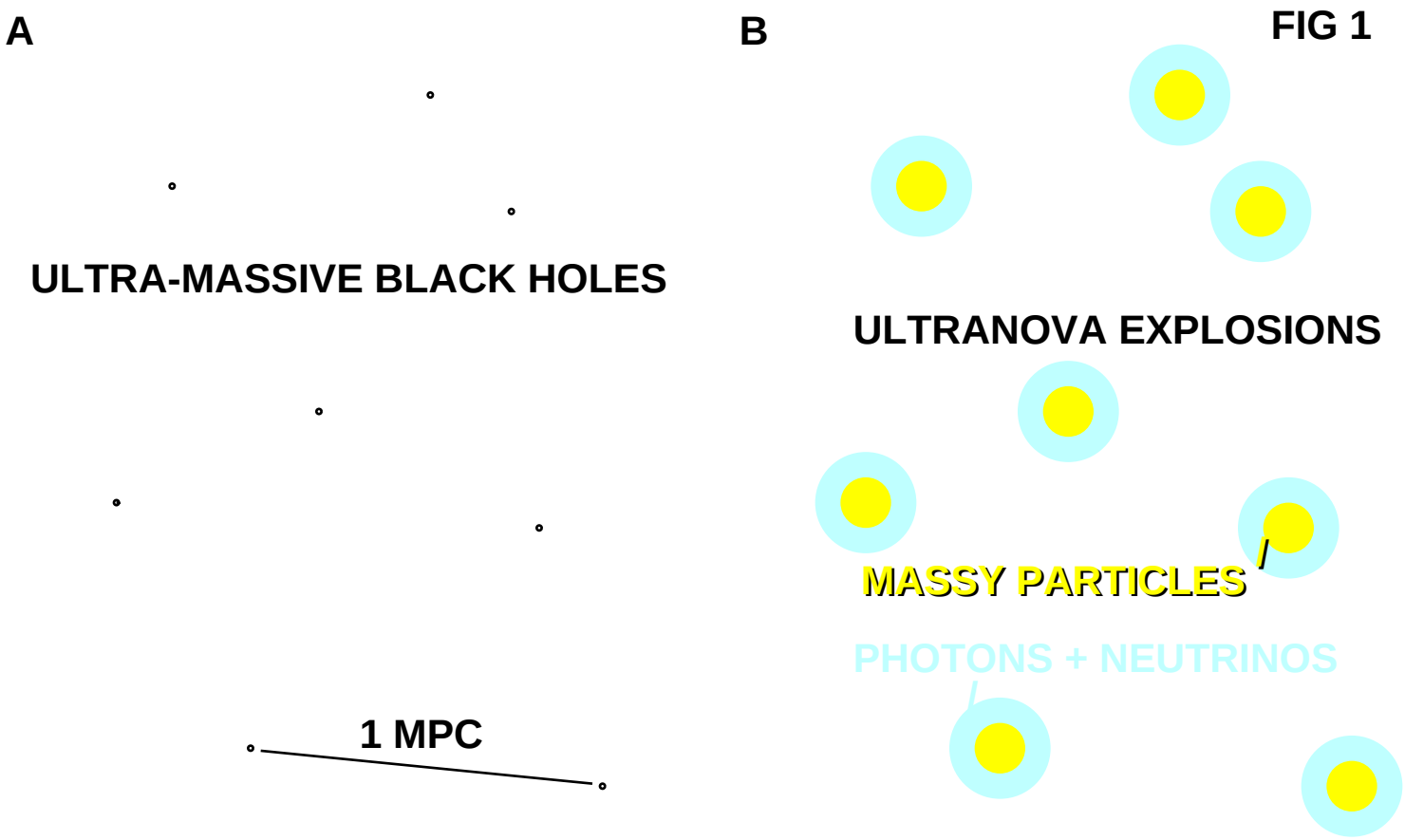
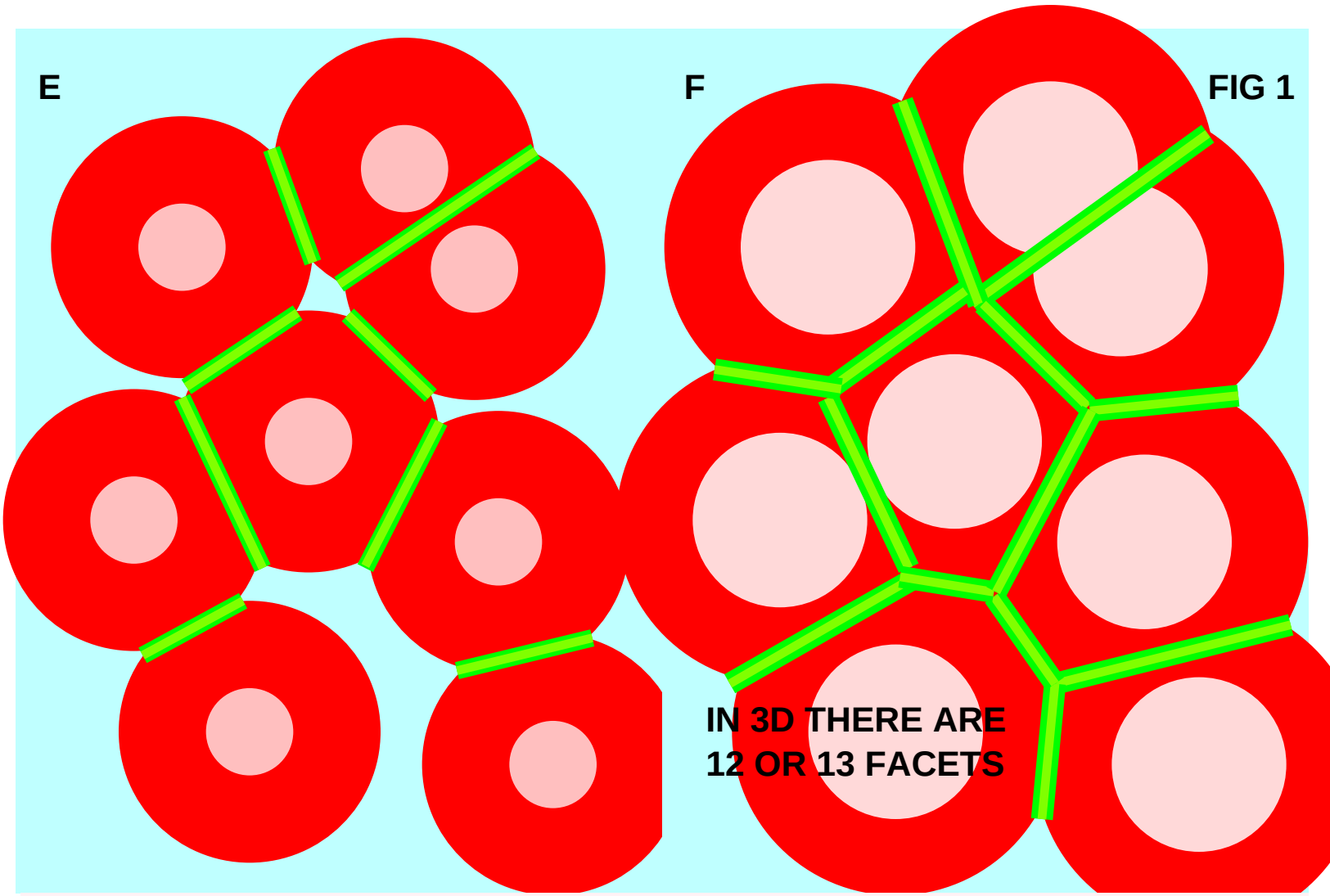
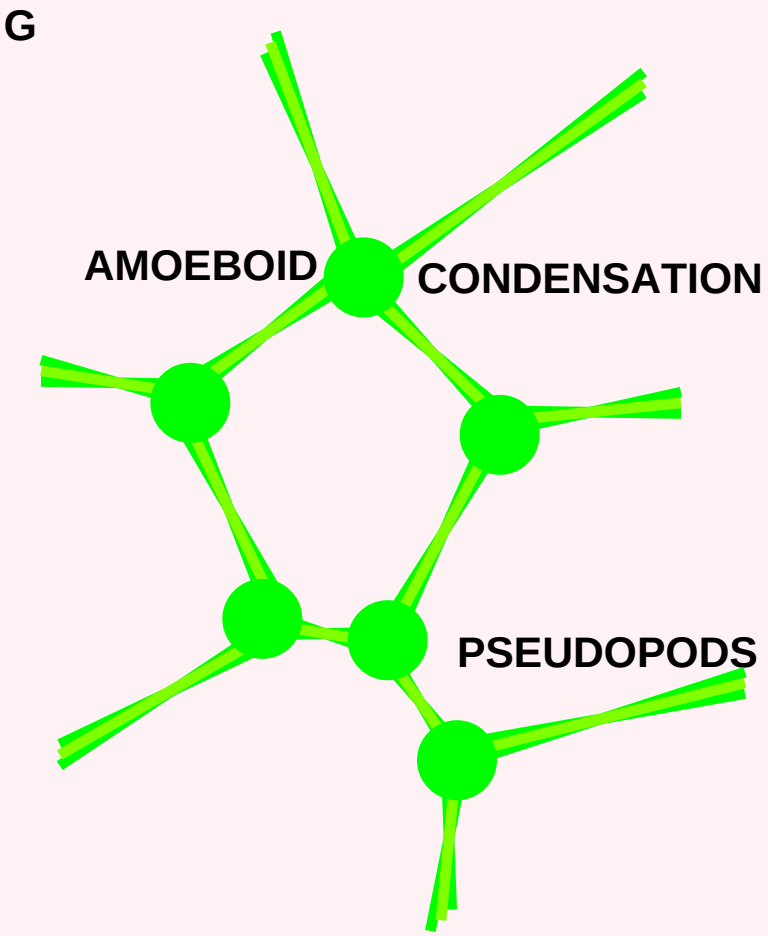
FIG 1


A
ULTRA-MASSIVE BLACK HOLES
1 MPC
B
ULTRANOVA EXPLOSIONS
MASSY PARTICLES
PHOTONS + NEUTRINOS
C
D
COLLISIONS FORM PERTUR-BATIONS


E
F
FIG 1
IN 3D THERE ARE
12 OR 13 FACETS


G
AMOEBOID
CONDENSATION
PSEUDOPODS

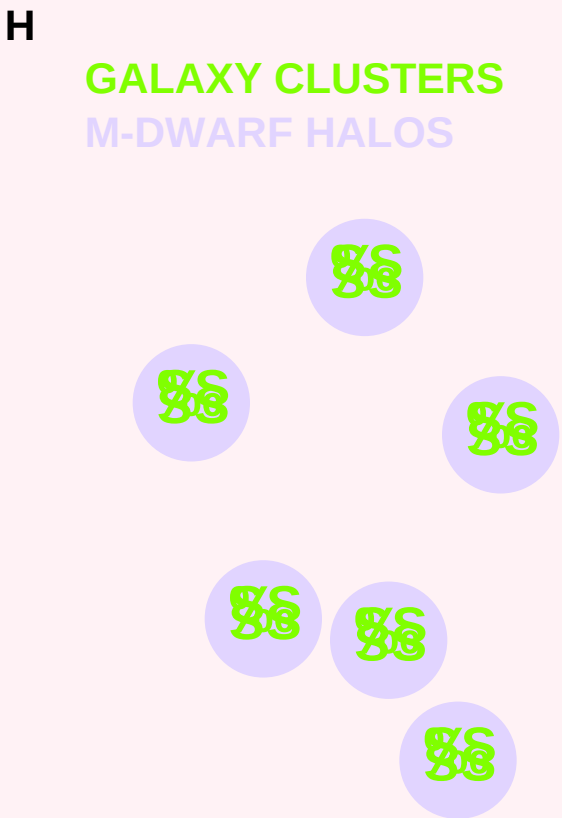
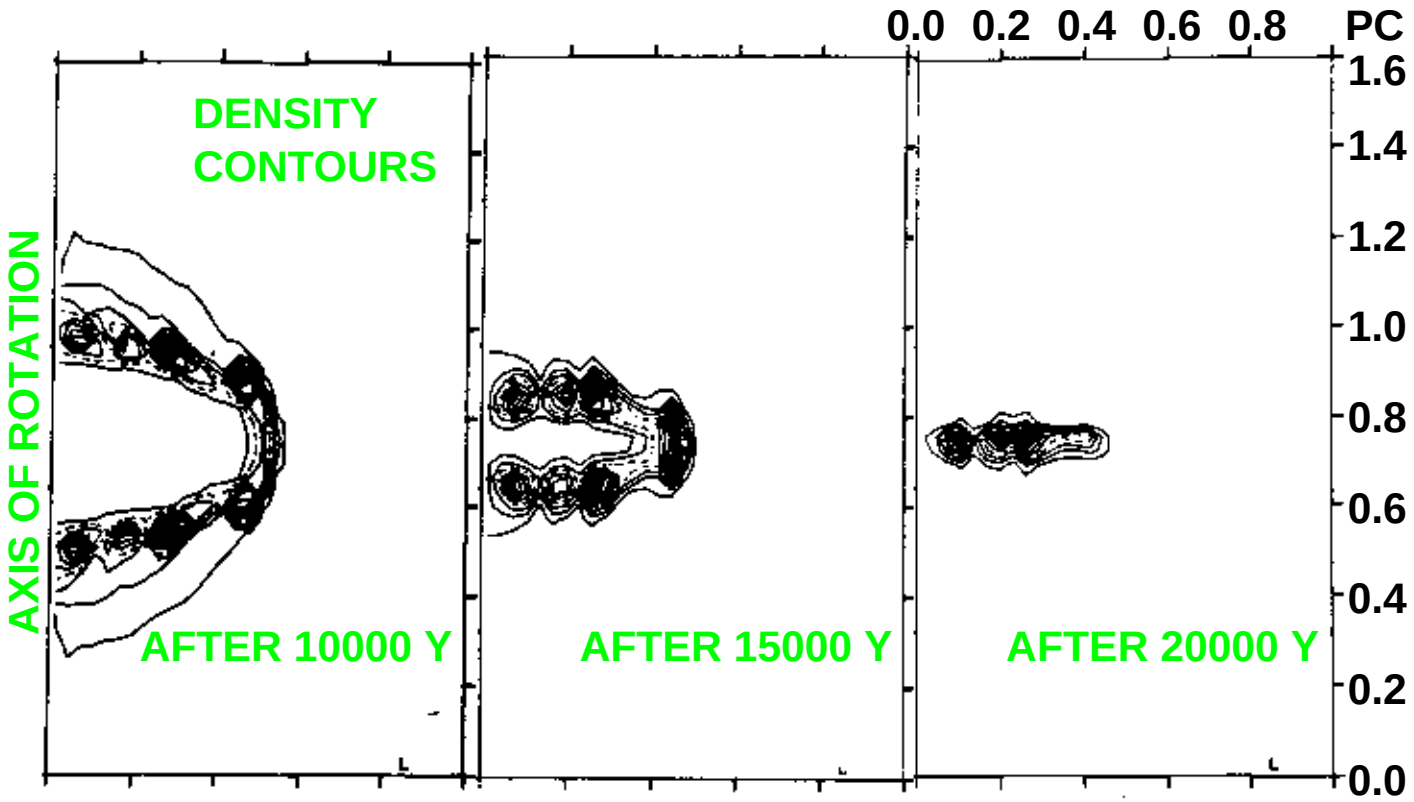

H
GALAXY CLUSTERS
M-DWARF HALOS

FIG 2

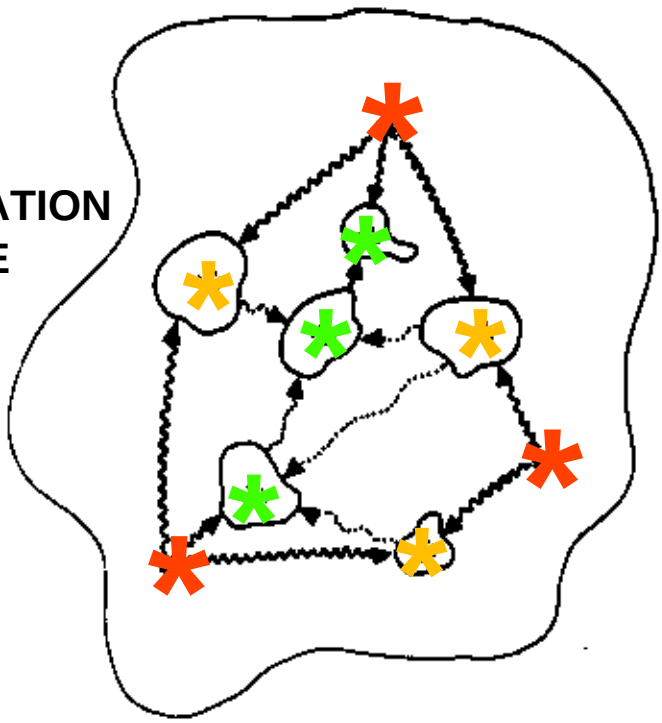
STAR FORMATION BY RADIATIVELY-DRIVEN IMPLOSION

KLEIN, SANDFORD, AND WHITAKER 1983
SANDFORD, WHITAKER, AND KLEIN 1982; 1984

IMPLOSION OF A CLOUD BETWEEN TWO O STARS



OPEN CLUSTER FORMATION THROUGH SUCCESSIVE GENERATIONS OF IMPLOSIONS



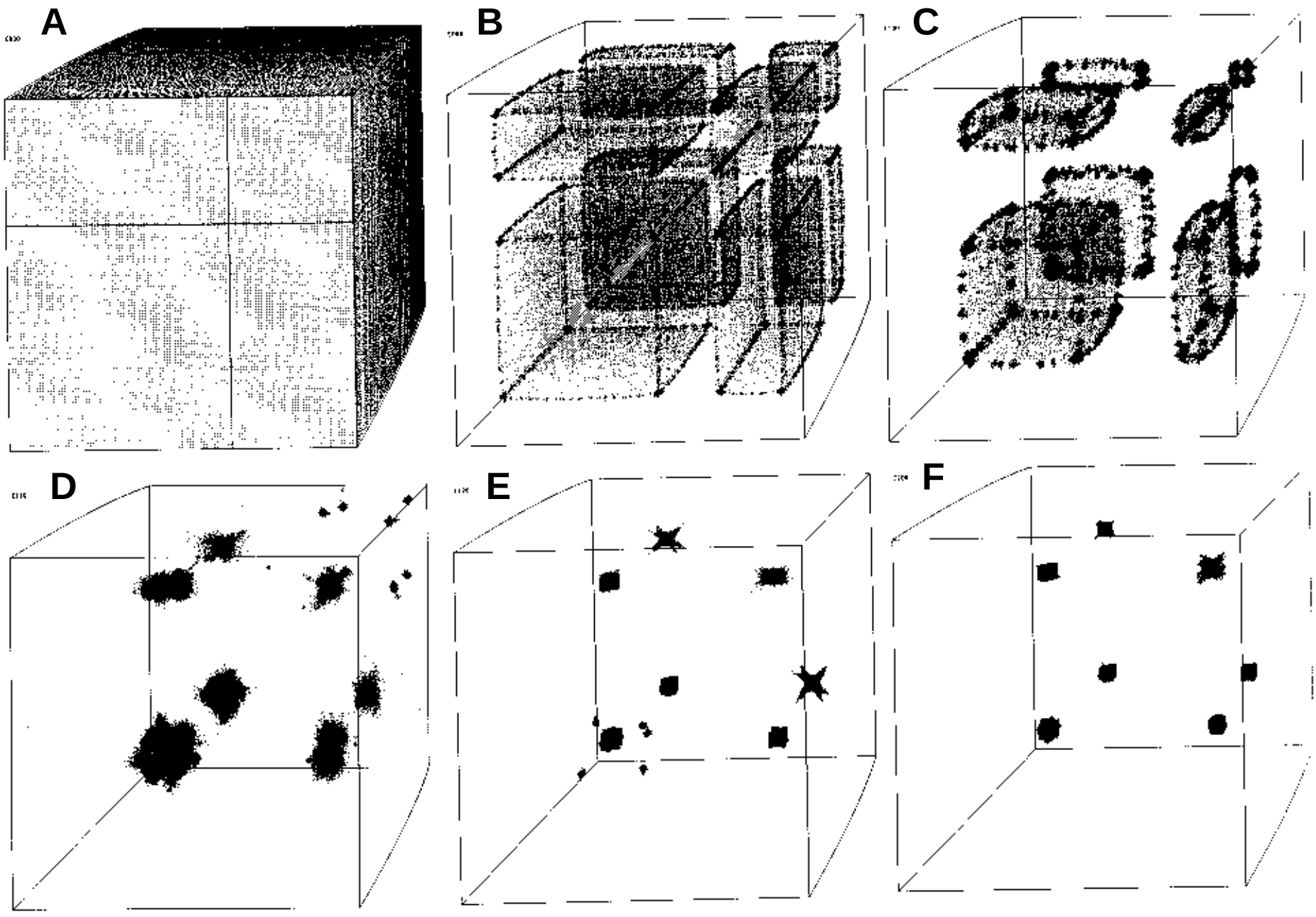
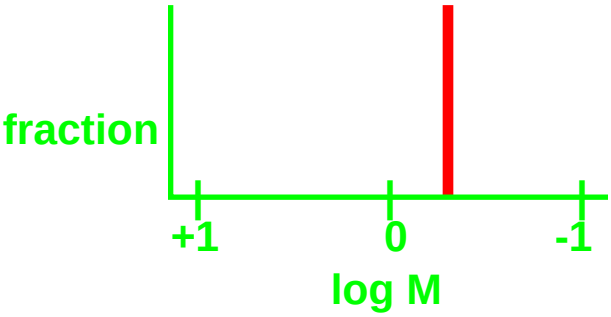


FIG 4

FIG 5

SCHEMATIC DISTRIBUTION FUNCTIONS FOR ISOLATED ELLIPTICAL GALAXIES



δ-function 1/2 Msun
total 10^{12} Msun

THEN

2×10^{12} STARS WITH 1/10 Lsun
IN ELLIPTICAL GALAXY TOO FAINT TO SEE
TRANSPARENT, CAN SEE OTHER GALAXIES THROUGH IT

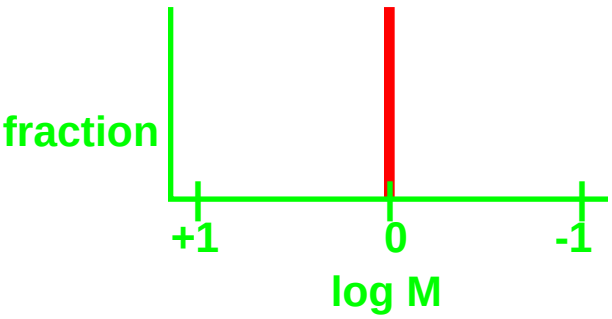
NOW AFTER ~15 GY

2×10^{12} STARS WITH ~ Lsun
IN FAINT ELLIPTICAL GALAXY
TRANSPARENT BUT
SMALL AMOUNT OF GAS FROM MASS LOSS
PRODUCES ABSORPTION LINES IN SPECTRA
SEEN THROUGH IT

EDITORIAL

ALWAYS CONSIDER THE EVOLUTIONARY PERSPECTIVE
WHAT WAS IT LIKE IN THE PAST?
WHAT WILL IT BE LIKE IN THE FUTURE?
DO NOT BE BLINDED BY VISUAL APPEARANCE NOW

FIG 6



δ-function 1 Msun

THEN

10^{12} STARS WITH Lsun
IN ELLIPTICAL GALAXY TOO FAINT TO SEE
HALO TRANSPARENT

5 GY AGO

GALAXY 500 TIMES BRIGHTER FOR, SAY, 1/10 GY
STARS LOSE 1/2 MASS > WHITE DWARFS
HALO OPAQUE WITH 5 x 10^{11} Msun
POP II GAS + 10^{12} WHITE DWARFS

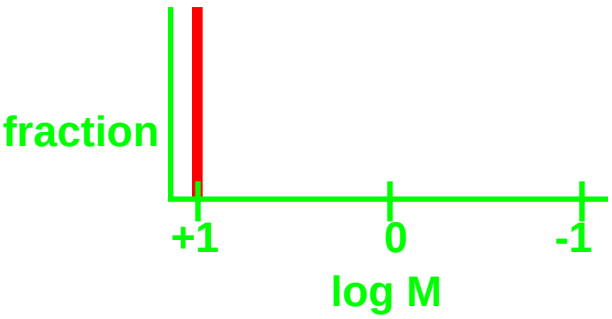
5-4 GY AGO

CLOUDS HAVE LARGE COLLISION CROSS-SECTIONS
IF IN HALO COALESCE AS IRREGULAR
IF AT CENTER OR DISK COALESCE AS SPIRAL
GAS + DUST FORM NEW STARS
ABUNDANCES HIGHER THAN ORIGINAL BUT STILL LOW
SOME NEW STARS ARE HIGH MASS
GALAXY BECOMES VERY BRIGHT

NOW

STILL VERY BRIGHT
LOW ABUNDANCE IRREGULAR OR SPIRAL
LOTS OF OPAQUE GAS + DUST
HALO NOT OBVIOUS

FIG 7



δ-function 10 Msun

THEN

10^{11} STARS WITH 10^{4} Lsun
VERY BRIGHT ELLIPTICAL GALAXY
TRANSPARENT

AFTER 0.01 - 0.1 GY

FEW SUPERNOVAS/DAY FOR FEW MY
ALL STARS SUPERNOVA
OPAQUE FROM MASS LOSS + SUPERNOVA REMNANTS
HALO FILLED WITH 10^{11} NEUTRON STARS
10^{11} SN REMNANTS COLLAPSE INTO DISK AND BULGE
REMNANTS CANNOT PASS THROUGH BULGE OR DISK
COLLAPSE IS ~ 1/2 ORBITAL PERIOD ~ 1/10 GY
CORE SPINS UP AND IS HEATED BY INFALL
BECOMES SUPERQUASAR THAT JETS OUT THE POLES
REMNANTS ARE HIGH METAL ABUNDANCE
BULGE + DISK FORM HIGH ABUNDANCE STARS

AFTER 1 GY

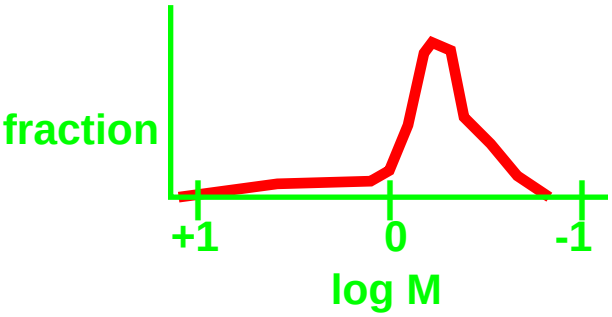
GALAXY IS DUSTY SPIRAL
WORN OUT QUASAR AT CENTER
HALO WITH 10^{11} DEAD STARS

NOW

LOOKS THE SAME
ENRICHED BY MANY GENERATIONS OF SUPERNOVAS
POP 0 STARS

FIG 8

MORE REALISTIC DISTRIBUTION FUNCTIONS FOR ISOLATED ELLIPTICAL GALAXIES



peak 2/3 Msun

THEN

~2 x 10^{12} STARS IN ELLIPTICAL GALAXY

~1% BRIGHT, SOME SUPERNOVA

IF HIGH MASS TAIL IS LARGE ENOUGH REMNANTS COLLECT AT CENTER AND PRODUCE QUASAR

NOW

LOOKS LIKE NORMAL ELLIPTICAL GALAXY

~10^{10} NEUTRON STARS

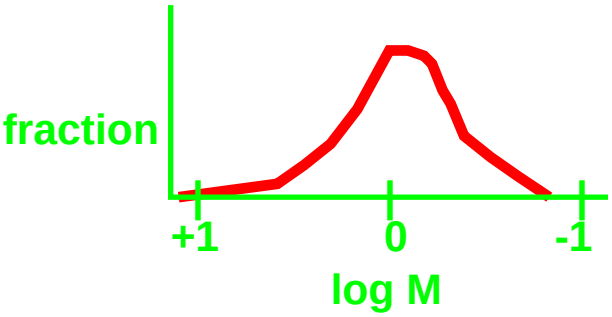
1-3 x 10^{11} WHITE DWARFS

MANY FAINT LOW MASS STARS

FUTURE

WILL STILL LOOK LIKE NORMAL ELLIPTICAL GALAXY

FIG 9



peak 1 Msun

THEN

~10^{12} STARS IN ELLIPTICAL GALAXY
GALAXY IS ALWAYS BRIGHT
ALWAYS HAS SUPERNOVAS AND SN REMNANTS
REMNANTS COLLECT AT CENTER
ACTIVE CORE OR QUASAR DEPENDING ON MASS

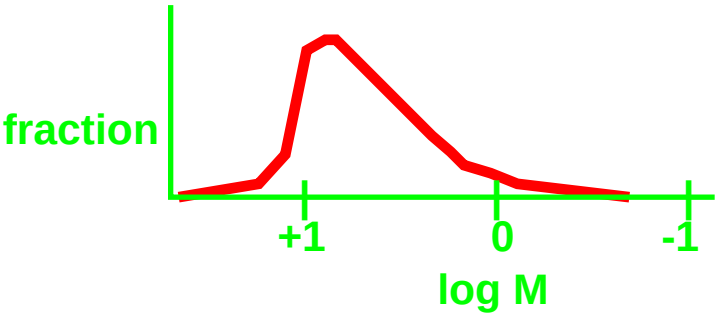
5 GY AGO

VERY BRIGHT WITH MANY BRIGHT SUPERGIANTS
TREMENDOUS AMOUNT OF GAS AND DUST
IF GAS COLLAPSES, A SPIRAL FORMS
HAS A QUASAR OR VERY ACTIVE CORE
IF NO ORGANIZED COLLAPSE
IRREGULAR GALAXY FORMS

NOW

MASSIVE HALO
10^{12} UNEVOLVED, K GIANT, AND DEAD STARS
LOTS OF STAR FORMATION
VERY BRIGHT
ABUNDANCES STILL LOW

FIG 10



peak 10 Msun

THEN

LIKE 10 Msun δ-function, FIG 7, BUT MODERATED
ONLY ~ 10^{10} SUPERNOVAS, A FEW PER MONTH

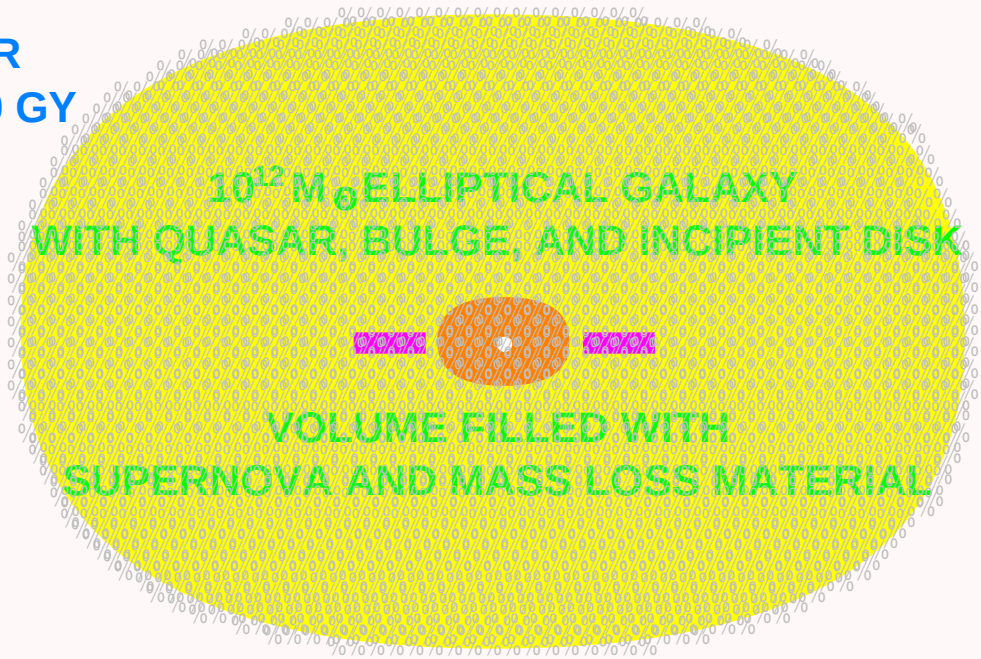
FIG 11

A THEN

10^{12} $M_\odot$ ELLIPTICAL GALAXY
MASS PEAK ~ 10 $M_\odot$

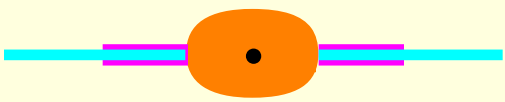
EXTERNAL
M-DWARF
HALO

B AFTER
0.5 - 1.0 GY



C NOW

10^{12} $M_\odot$ SPIRAL GALAXY
WITH HALO, INACTIVE QUASAR, BULGE,
THICK DISK, AND THIN DISK

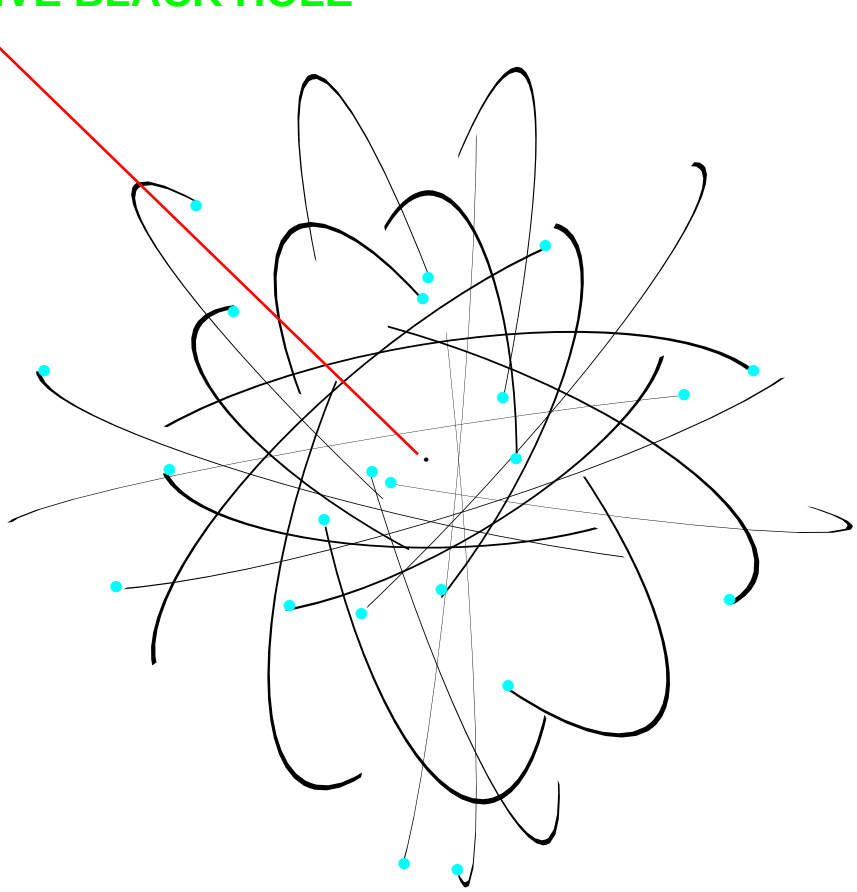


BLACK HOLES, NEUTRON STARS,
AND WHITE DWARFS FILL HALO

FIG 11

D NOW **THE INACTIVE QUASAR**

SUPER-MASSIVE BLACK HOLES ARE ORBITED BY MASSIVE KERBEREAN BLACK HOLES THAT PREVENT MATTER FROM ACCRETING ON TO THE SUPER-MASSIVE BLACK HOLE



KERBEREAN BLACK HOLES COLLECT THE MATTER AND ANGULAR MOMENTUM OF STARS, GAS, LOW-MASS BLACK HOLES FALLING TOWARD A GALACTIC CENTER.

IN A GALAXY COLLISION, INFALL MATERIAL CAN OVERWHELM THE KERBEREAN BLACK HOLES AND REACH THE CENTER TO SET OFF AN AGN

FIG 12

CLASSIFICATION OF GALAXIES

ISOLATED WITH NO STRIPPING AND NO MERGERS

HUBBLE CLASSIFICATION IS SUPERFICIAL MORPHOLOGY

ALL GALAXIES ARE PRIMORDIAL AND ELLIPTICAL

PHYSICAL VARIABLES

- MASS
- DISTRIBUTION FUNCTION OF THE MASSES (IMF)
  - OF THE ORIGINAL POP II STARS
  - PEAK MASS, HIGH-MASS TAIL, LOW-MASS TAIL
- ANGULAR MOMENTUM, ETC

ELLIPTICALS

ANON MANY FAINT, TRANSPARENT WITH VERY LOW-MASS PEAK

M32 LOW MASS, LOW-MASS PEAK, FAINT UNTIL RECENTLY.

M87 HIGH MASS, LOW-MASS PEAK, ENOUGH HIGH-MASS TAIL TO PRODUCE QUASAR

IRREGULARS

SMC SMALL MASS, MEDIUM-MASS PEAK. MUCH POP II MASS LOSS SEVERAL GY AGO. CONTINUAL STARBURST SINCE.

LMC MEDIUM MASS, MEDIUM-MASS PEAK. MUCH POP II MASS LOSS SEVERAL GY AGO. CONTINUAL STARBURST SINCE. HIGH-MASS TAIL WAS STRONGER THAN LMC'S SO HIGHER ABUNDANCES IN NEW STARS

SPIRALS

M33 LOW MASS, HIGH-MASS PEAK. EVOLVES AS IN FIG 11.

M31 HIGH MASS, HIGH-MASS PEAK. EVOLVES AS IN FIG 11.

MW HIGH MASS, HIGH-MASS PEAK. EVOLVES AS IN FIG 11.

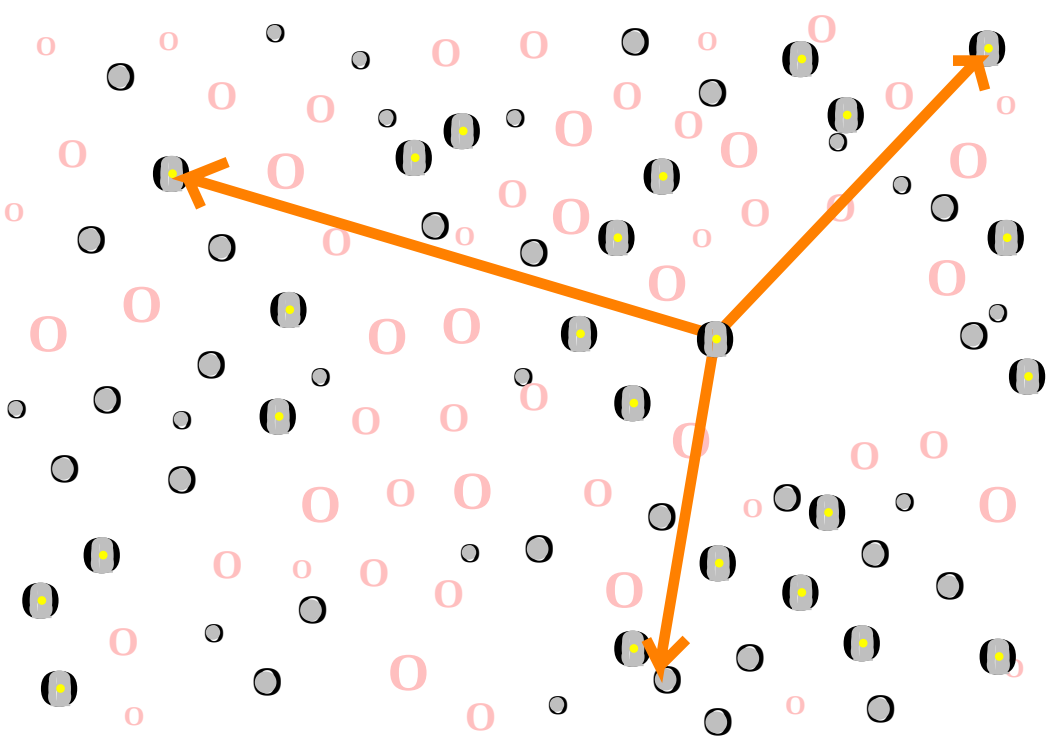
FIG 13

MAKING VOIDS WITH RADIATION PRESSURE

GALAXIES THAT WERE FORMED WITH A SIGNIFICANT NUMBER OF MASSIVE STARS HAVE OPAQUE HALOS

LARGER GALAXIES HAVE STRONG QUASARS AT THEIR CENTERS

QUASAR RADIATION AND INFRARED RE-RADIATION IS ABSORBED BY OTHER OPAQUE GALAXIES (EXCEPT RADIO)

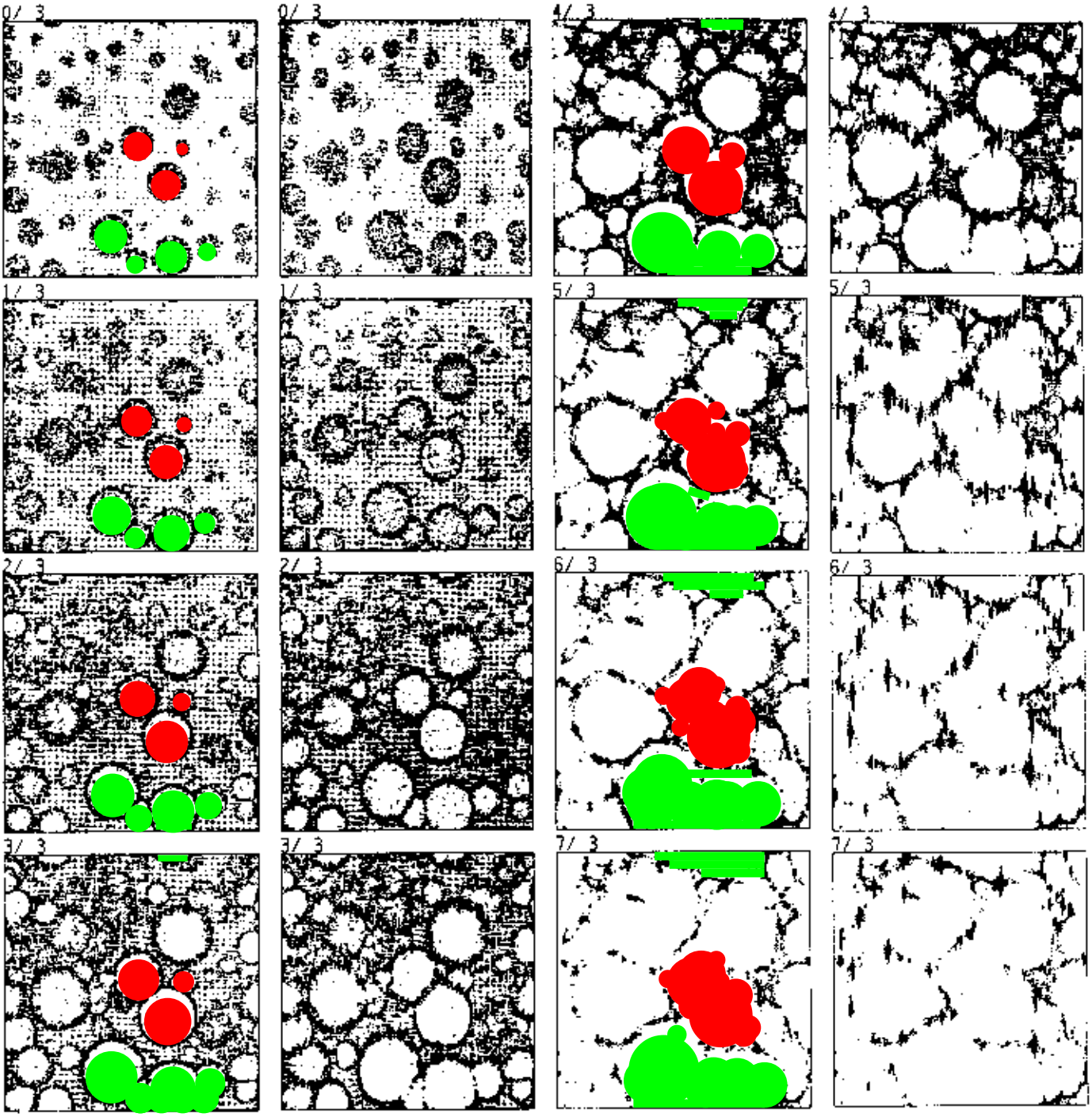


STATISTICALLY, RANDOM CLUMPS OF QUASARS PRODUCE VOIDS WITH EXCESS RADIATION PRESSURE

GALAXIES WITH TRANSPARENT HALOS ARE DRAGGED ALONG BY GRAVITY

FIG 14

EVOLUTION OF VOIDS AND LARGE SCALE STRUCTURE



REAL SPACE | REDSHIFT SPACE | REAL SPACE | REDSHIFT SPACE

REGŐS AND GELLER (1991) MODELLED COSMOLOGICAL EVOLUTION OF VOIDS UP TO THE PRESENT TIME. THESE ARE 5% 2D SLICES THROUGH THE 3D PERIODIC CUBIC STRUCTURE. DENSE AREAS IN THE FINAL PANELS ARE CLUSTERS OF GALAXIES.

FIG 15

CONTENTS OF OUR GALAXY

HALO

~10^{7} POP III NEUTRON STARS OR BLACK HOLES
FROM SUPERMASSIVE POP III STARS

~10^{11} POP II NEUTRON STARS OR BLACK HOLES
FROM MASSIVE POP II STARS

~3 x 10^{11} WHITE DWARFS
FROM INTERMEDIATE MASS POP II STARS

~10^{11} K + M STARS
INITIAL POP II

~10^{2} GLOBULAR CLUSTERS
INITIAL POP II

BULGE

1 INACTIVE QUASAR, SUPERMASSIVE BLACK HOLE

~10^{2} MASSIVE BLACK HOLES

~10^{6} STELLAR BLACK HOLES

~10^{11} HIGH ABUNDANCE POP II K + M STARS

~10^{2} GLOBULAR CLUSTERS
MADE FROM POP II SUPERNOVA REMNANT INFALL

~10^{10} WHITE DWARFS AND NEUTRON STARS
FROM EVOLVED BULGE STARS

THICK DISK

~10^{9} BULGE STARS
ESCAPED OR PULLED OUTWARD INTO DISK

~10^{9} INTERMEDIATE POP I-II STARS
FROM MIXED HALO AND BULGE MASS LOSS

THIN DISK

~10^{9} OLD STARS WITH ABUNDANCES LOWER THAN BULGE
FROM POP II MASS LOSS THAT COLLAPSES INTO DISK

~10^{11} POP I STARS OF INCREASINGLY HIGHER ABUNDANCE
FROM POP I GAS AND DUST LOCALLY PRODUCED

~10^{11} Msun GAS AND DUST
FROM POP I MASS LOSS AND SUPERNOVAS

~10^{10} WHITE DWARFS AND NEUTRON STARS
FROM EVOLVED POP I STARS