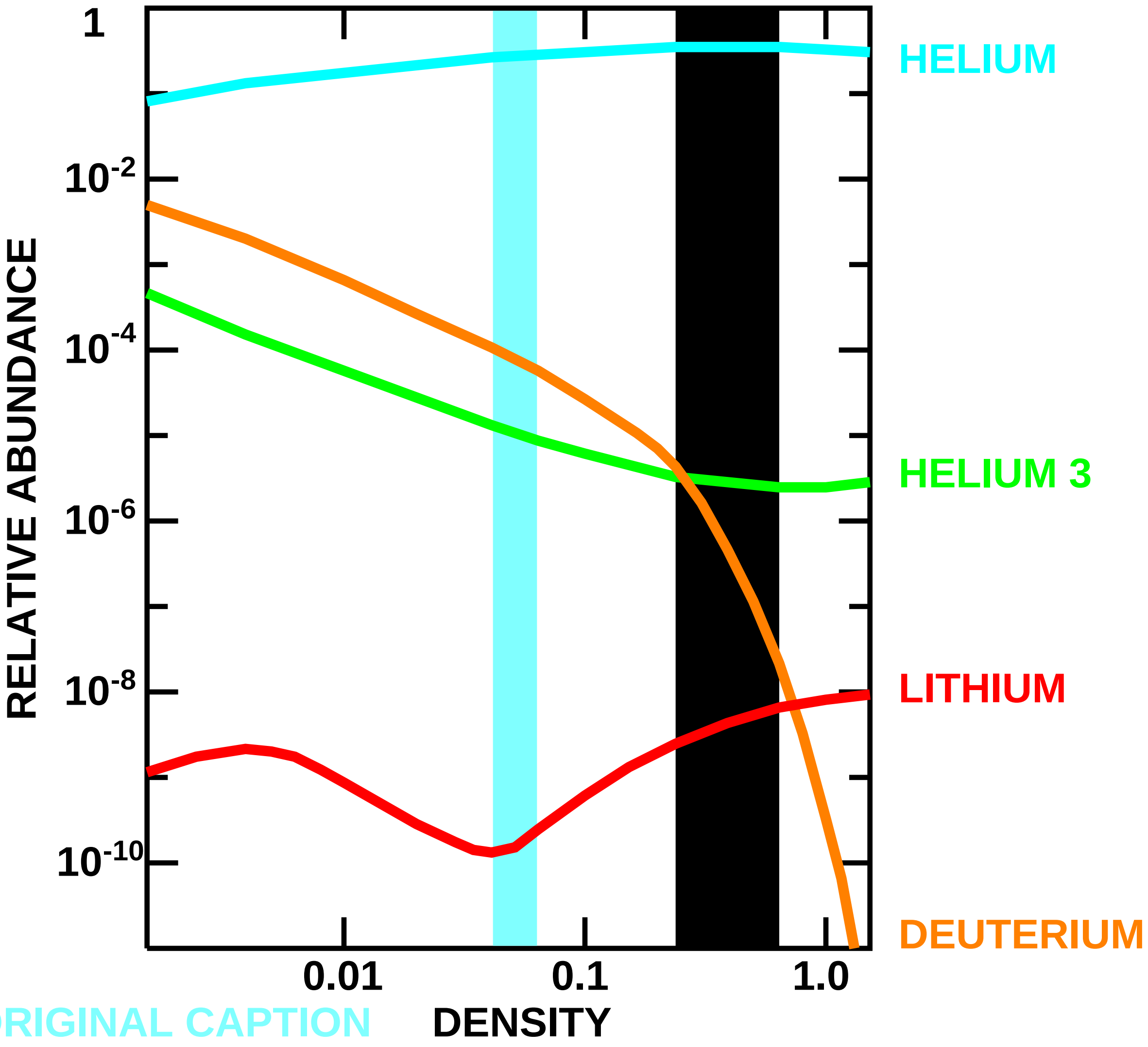
FIG 1

PRIMORDIAL ABUNDANCES

FIGURE BASED ON PEEBLES, SCHRAMM, TURNER, AND KRON IN SCIENTIFIC AMERICAN, OCTOBER 1994, PP. 52-57.

LIGHT BLUE REGION ENCOMPASSES INCORRECT OBSERVED ABUNDANCES THAT IMPLY A LOW DENSITY UNIVERSE.

BLACK REGION ENCOMPASSES THE TRUE ABUNDANCES THAT IMPLY A DENSITY SUFFICIENT TO CLOSE THE UNIVERSE AND THAT DARK MATTER IS BARYONIC.



ORIGINAL CAPTION

DENSITY of neutrons and protons in the universe determined the abundances of certain elements. For a higher density universe the computed helium abundance is little different, and the computed abundance of deuterium is considerably lower. The shaded region is consistent with the observations, ranging from an abundance of 24 percent for helium to one part in 10^{10} for the lithium isotope. The quantitative agreement is a prime success of the big bang cosmology.

FIG 2

SCHEMATIC PERTURBATION SPECTRA

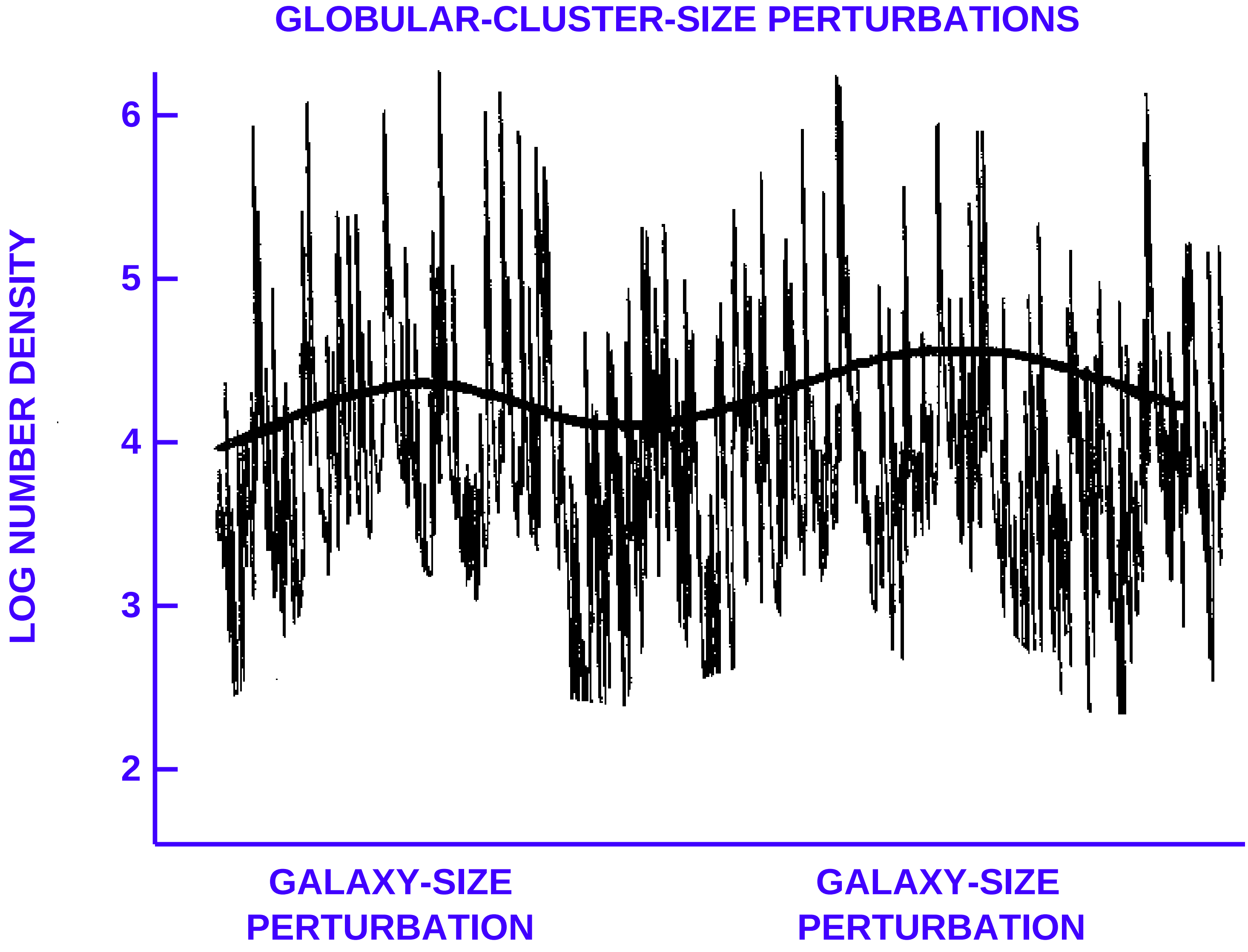
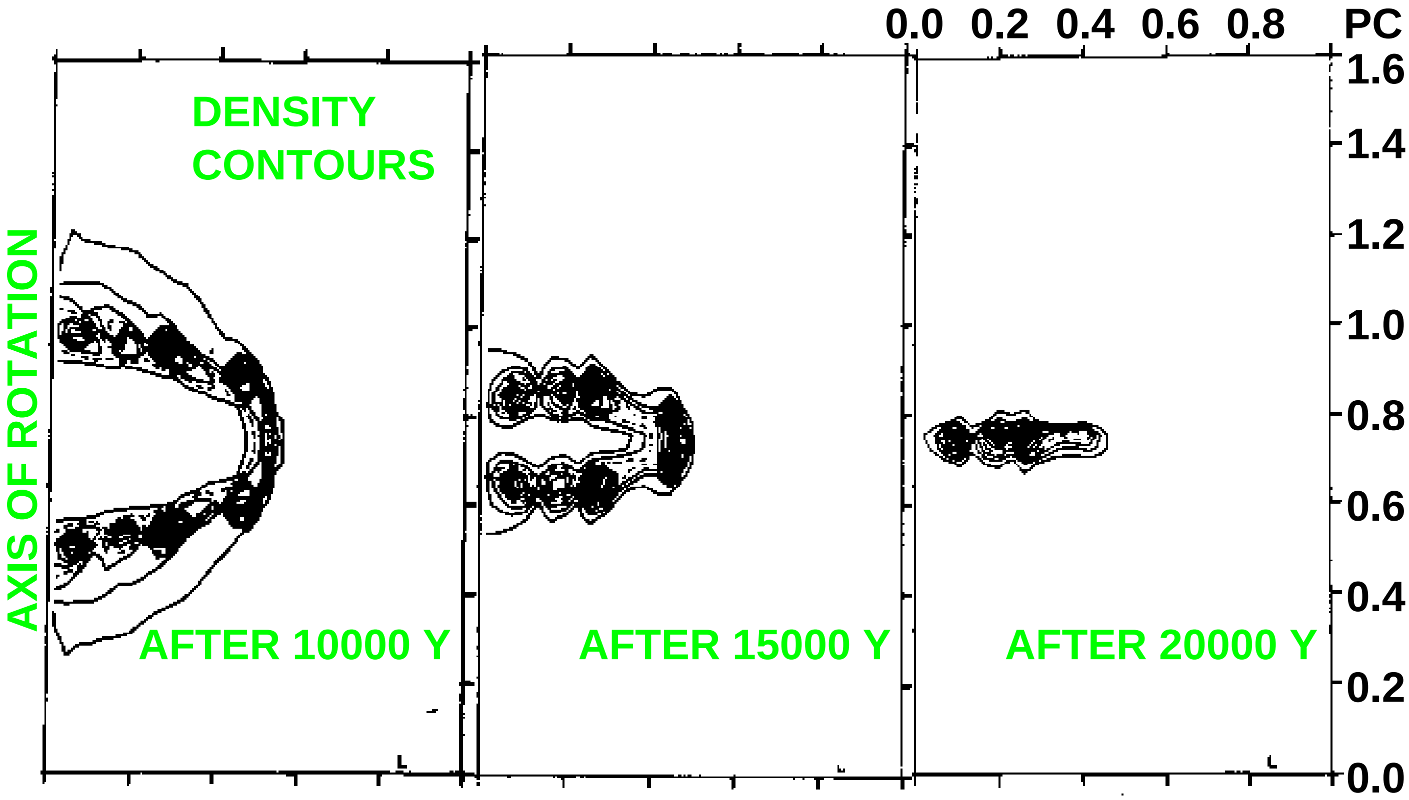


FIG 3

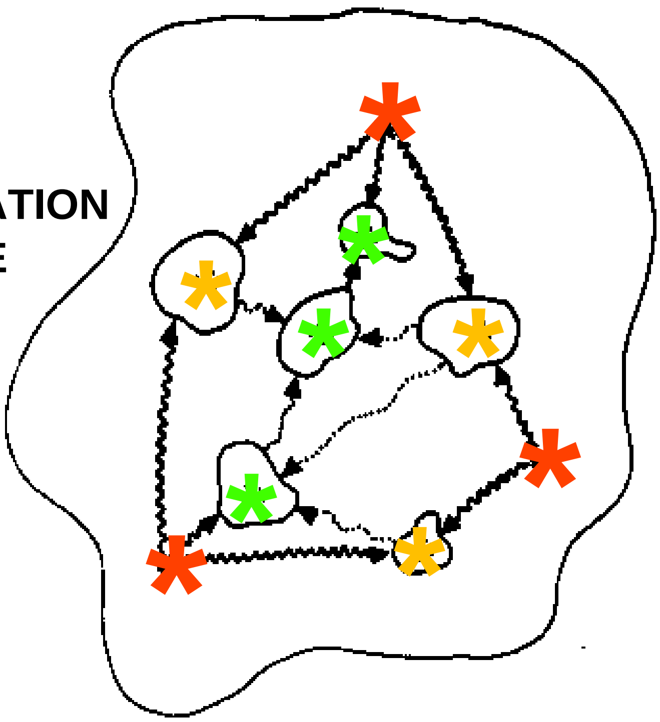
STAR FORMATION BY RADIATIVELY-DRIVEN IMPLOSION

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



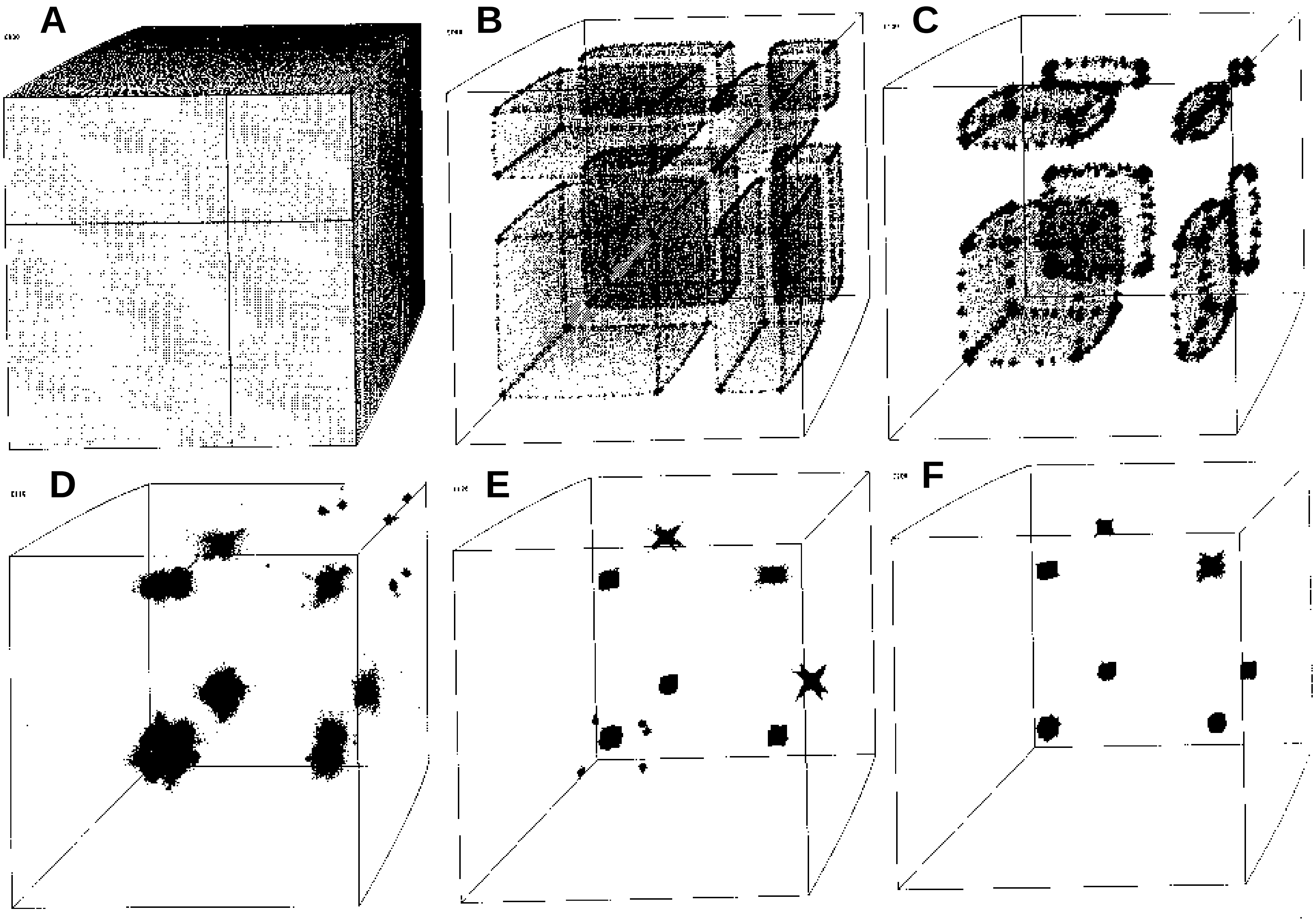
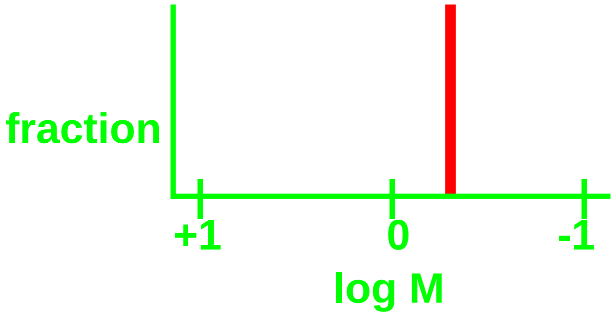


FIG 4

FIG 5

SCHEMATIC DISTRIBUTION FUNCTIONS FOR ISOLATED ELLIPTICAL GALAXIES



δ-function 1/2 $M_\odot$
total 10^{12} $M_\odot$

THEN

2 x 10^{12} STARS WITH 1/10 $L_\odot$
IN ELLIPTICAL GALAXY TOO FAINT TO SEE
TRANSPARENT, CAN SEE OTHER GALAXIES THROUGH IT

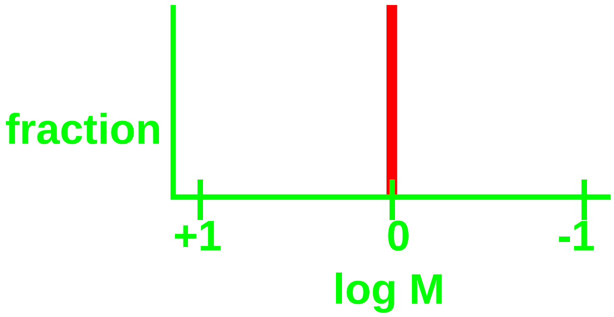
NOW AFTER ~15 GY

2 x 10^{12} STARS WITH ~ $L_\odot$
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 $1\ M_{\odot}$

THEN

10^{12} STARS WITH $L_{\odot}$

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 $5 \times 10^{11}\ M_{\odot}$

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

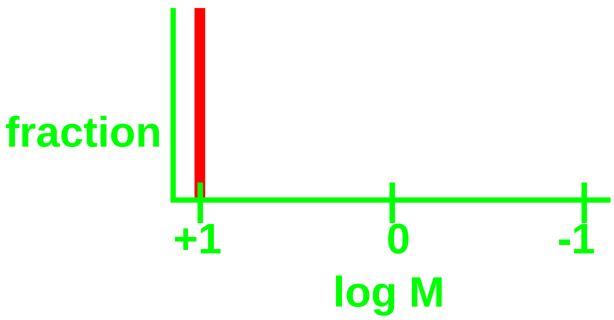
STILL VERY BRIGHT

LOW ABUNDANCE IRREGULAR OR SPIRAL

LOTS OF OPAQUE GAS + DUST

HALO NOT OBVIOUS

FIG 7



δ-function 10 $M_\odot$

THEN

10^{11} STARS WITH 10^4 $L_\odot$

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

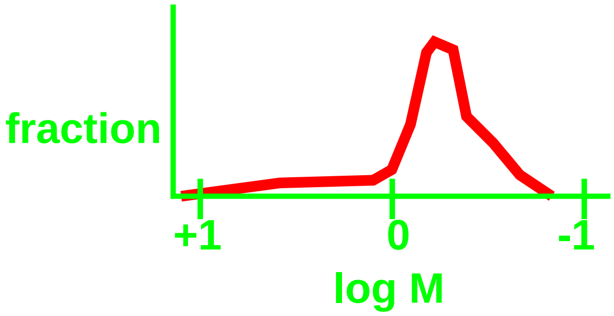
LOOKS THE SAME

ENRICHED BY MANY GENERATIONS OF SUPERNOVAS

POP 0 STARS

FIG 8

MORE REALISTIC DISTRIBUTION FUNCTIONS FOR ISOLATED ELLIPTICAL GALAXIES



peak 2/3 $M_\odot$

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

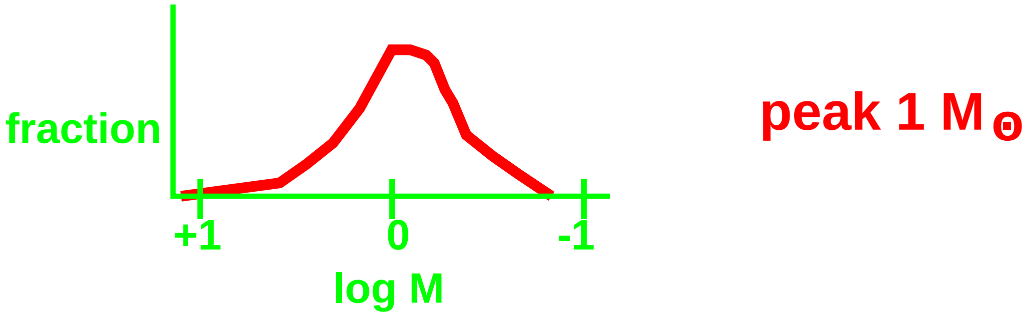
NOW

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



THEN

$\sim 10^{12}$ 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

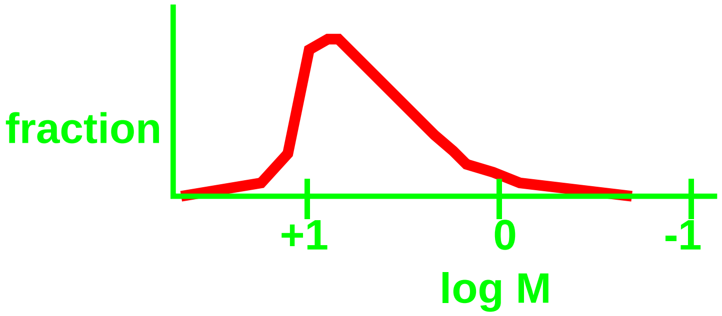
5 GY AGO

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 $M_\odot$

THEN

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

FIG 11

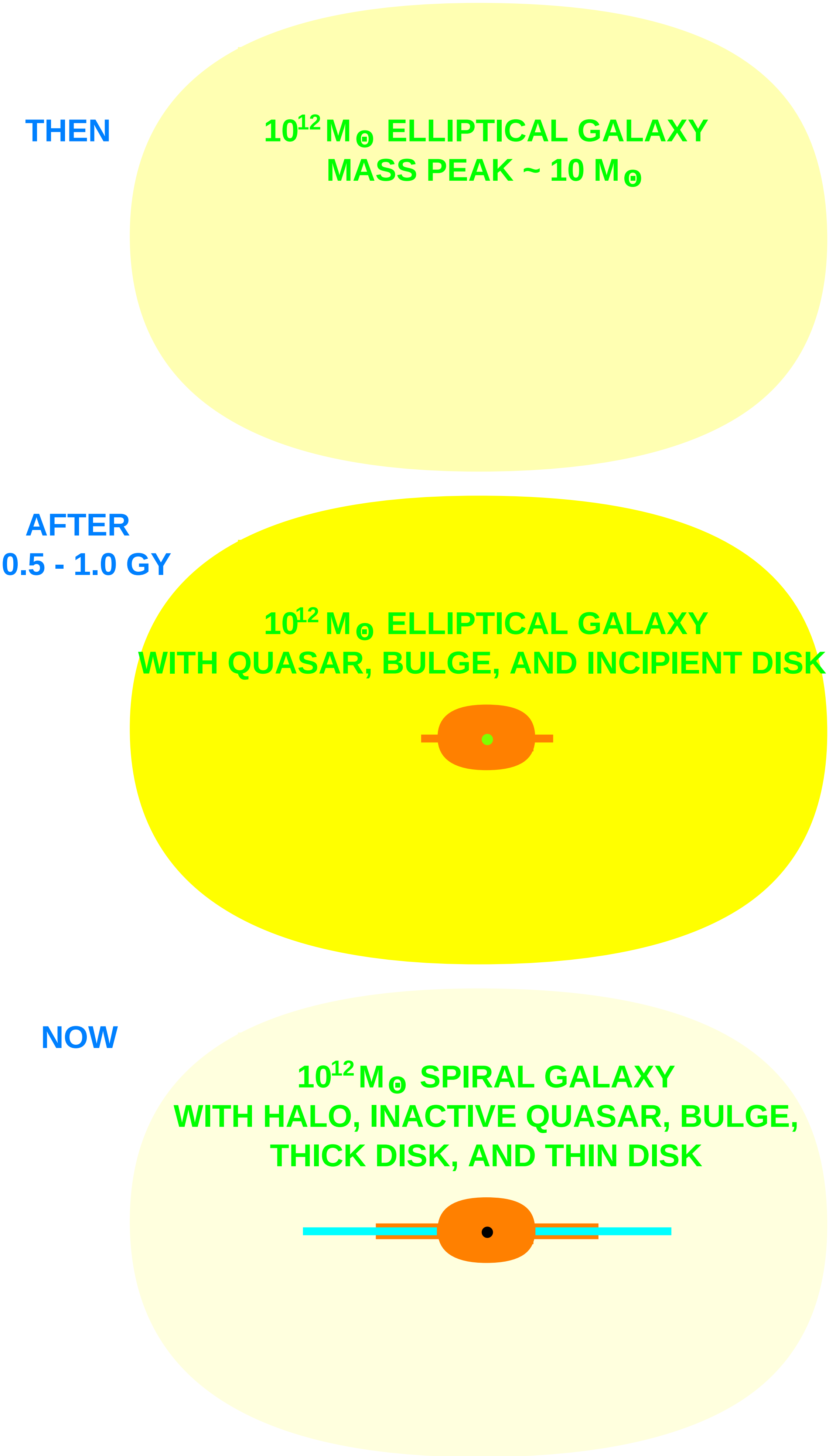

THEN
$10^{12} M_\odot$ ELLIPTICAL GALAXY
MASS PEAK ~ 10 $M_\odot$
AFTER
0.5 - 1.0 GY
$10^{12} M_\odot$ ELLIPTICAL GALAXY
WITH QUASAR, BULGE, AND INCIPIENT DISK
NOW
$10^{12} M_\odot$ SPIRAL GALAXY
WITH HALO, INACTIVE QUASAR, BULGE,
THICK DISK, AND THIN DISK

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.

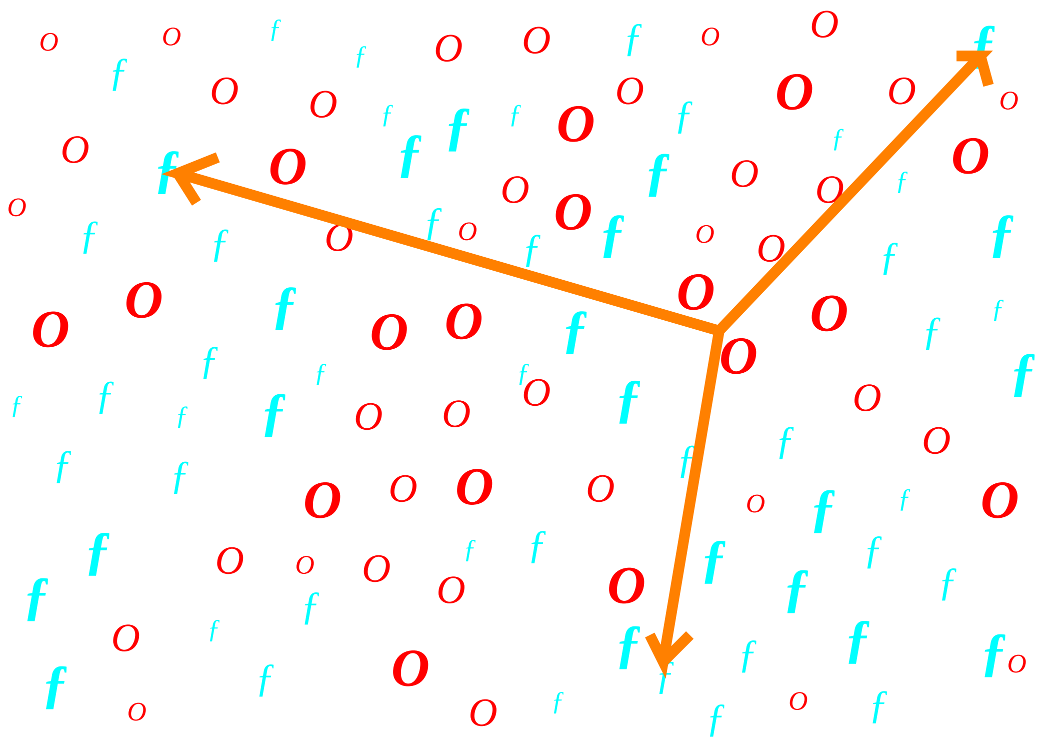
FIG 13

MAKING VOIDS WITH RADIATION PRESSURE

THERE ARE ~10^{12} GALAXIES WITHIN OUR HORIZON

UNTIL Z ~ 5 GALAXIES WERE SO MUCH CLOSER THAN NOW THAT, STATISTICALLY, A CLUMP OF, SAY, 10^{5} GALAXIES COULD BE OPTICALLY THICK

ALL RADIATION FROM NEAR THE CENTER IS ABSORBED (EXCEPT RADIO)

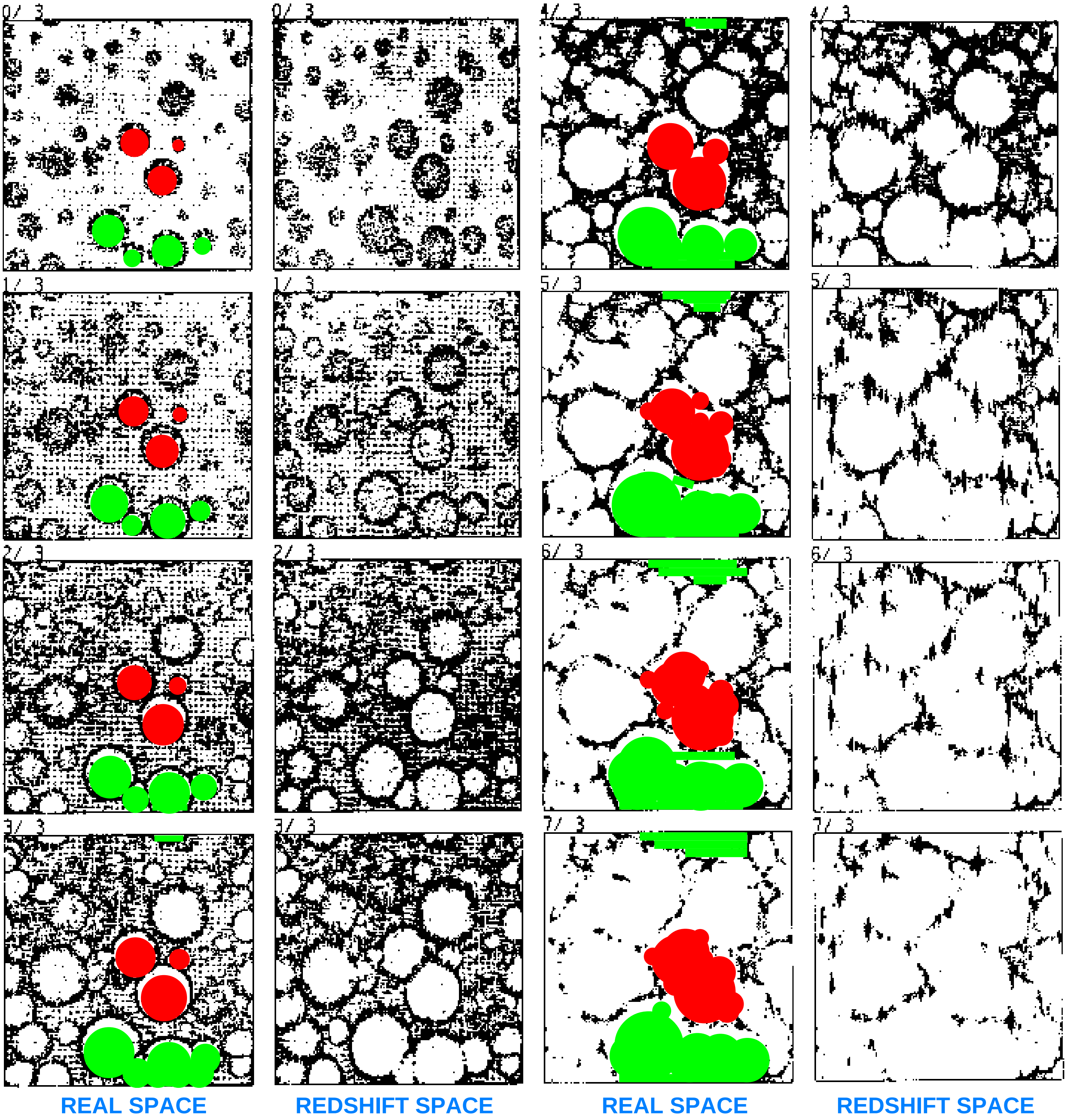


OPAQUE GALAXIES ABSORB THE RADIATION AND ARE ACCELERATED OUTWARD

THEY DRAG ALONG THE ELLIPTICALS GRAVITATIONALLY

FIG 14

EVOLUTION OF VOIDS AND LARGE SCALE STRUCTURE



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

$\sim 10^{7}$ POP III NEUTRON STARS OR BLACK HOLES
FROM SUPERMASSIVE POP III STARS

$\sim 10^{11}$ POP II NEUTRON STARS
FROM MASSIVE POP II STARS

$\sim 3 \times 10^{11}$ WHITE DWARFS
FROM INTERMEDIATE MASS POP II STARS

$\sim 10^{11}$ K + M STARS
INITIAL POP II

$\sim 10^{2}$ GLOBULAR CLUSTERS
INITIAL POP II

BULGE

1 INACTIVE QUASAR AT CENTER

$\sim 10^{11}$ HIGH ABUNDANCE POP II K + M STARS

$\sim 10^{1}$ GLOBULAR CLUSTERS
ALL FROM POP II SUPERNOVA REMNANT INFALL

$\sim 10^{10}$ WHITE DWARFS
FROM EVOLVED BULGE STARS

THICK DISK

$\sim 10^{9}$ BULGE STARS
ESCAPED OR PULLED OUTWARD INTO DISK

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

THIN DISK

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

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

$\sim 10^{11}$ $M_{\odot}$ GAS AND DUST
FROM POP I MASS LOSS AND SUPERNOVAS

$\sim 10^{10}$ WHITE DWARFS AND NEUTRON STARS
FROM EVOLVED POP I STARS