

# LIFE IN THE UNIVERSE EXAM 1 REVIEW SHEET

## LIGHT

Electromagnetic spectrum order ( $\gamma$ , X, UV, visible, IR, radio)

Wien's Law & Stefan-Boltzmann Law – what happens as T is raised/lowered? (i.e. by 2x, 3x, ..)

Humans & (most) planets *reflect* visible & *radiate* IR

Inverse square law

Doppler effect

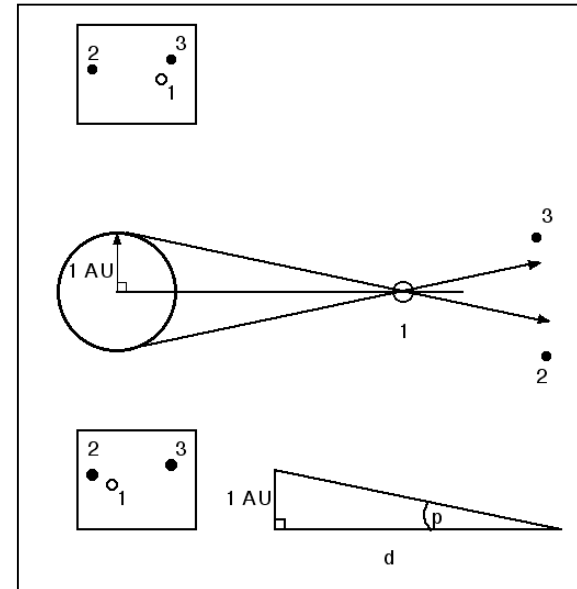
## SCALE OF THE UNIVERSE

Stellar parallax  $d(\text{pc}) = 1/\text{parallax}(\text{arcsec})$

Note what happens if you look back the other way!

Milky Way contains about 300 billion stars

The universe contains over 100 billion galaxies



## CHEMICAL HISTORY OF THE UNIVERSE

H present very near the start of the Big Bang

He produced by H-fusion (“burning”) when the universe was about 3 minutes old

Main Sequence stars begin fusing (“burning”) H to He in their cores

CNO cycle of H-burning builds up N at the expense of any C & O present

C & O produced by He-burning

Many heavier elements produced by C-burning, Ne-burning, O-burning, and Si-burning  
As time progresses, more “heavies” are produced  
Stars “inherit” products from generations of stars (Pop I from Pop II, Pop II from Pop III)  
Terrestrial planets are made of “heavies” .....

## **INTERSTELLAR MEDIUM & STAR FORMATION**

Atomic Gas

H I produces 21-cm emission line

Dust

Mostly carbon compounds & silicates; evaporate if  $T > 1200$  K

May also include water ice if  $T < 150$  K

Redden starlight by removal of shorter wavelengths

The World of Sir Fred

Molecular gas

Mostly exist in giant molecular clouds

H<sub>2</sub> most abundant, followed by CO

Most complex molecules rely on chains & rings of C

Most stars form with a disk of gas & dust that can form planets

Our own solar system is about 4.5 billion years old

## **STAR DEATH**

Most stars are main sequence stars – most spend the bulk of their lives fusing H into He in cores

Low-mass stars live longer than high-mass ones, with lifetimes  $\sim 1/M^2$

Our own sun will last about 10 billion years

Stars return the products of nuclear fusion via planetary nebulae & novae & supernovae

## **LIFE-BASICS**

All life on earth is based on the same set of 20 amino acids

Almost all amino acids used by terrestrial life is L-type

Non-biological production of organics often produces equal L- and D-types

All amino acids in living organisms are made from CHON, and 2 also have S

## **LIFE IN ACTION**

Development of life proceeds from simpler organisms to more complex ones

The early earth had no free O so anaerobic organisms preceded aerobic ones

Genetic mutations can occur via many mechanisms - transcription errors, chemicals, CRs, etc

Mutations may be harmful, helpful, or “neutral” (no immediate effects)

Plants make organics & oxygen via photosynthesis:  $6 \text{CO}_2 + 6 \text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$

Animals eat organics & consume oxygen that effectively reverses this process

## **THE MACHINERY OF LIFE**

Interstellar space, solar system, Earth

Advantages of water and carbon

The “RNA World”

Monomers & polymers

Synthesis of proteins from amino acids

Mitochondria