Package ‘cosmoFns’

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Type Package

Title Functions for cosmological distances, times, luminosities, etc.

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Description Package encapsulates standard expressions for distances, times, luminosities, and other quantities useful in observational cosmology, including molecular line observations. Currently coded for a flat universe only.

License GPL (>= 2)

LazyLoad yes

Repository CRAN

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cosmoFns-package *Cosmology functions*

Description

Package contains functions for computation of distances and luminosities in a flat cosmology.

Details

Package:	cosmoFns
Type:	Package
Version:	1.0-1
Date:	2012-09-16
License:	GPL
LazyLoad:	yes

Author(s)

A. Harris

Maintainer: <harris@astro.umd.edu>

References

"Distance Measures in Cosmology," D.W. Hogg (2000), arXiv:astro-ph/9905116; "Warm Molecular Gas in the Pirmeval Galaxy 10214+4724", P.M. Solomon, D. Downes, and S.J.E. Radford (1992), Ap.J. 398, L29; "First-year WMAP observations...", Spergel et al., ApJS 148:175 (2003).

Examples

```
D.L(z=2.3)
```

D.A *Angular diameter distance*

Description

Function computes angular diameter distance

Usage

```
D.A(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Angular distance in Mpc

Note

For flat universe, `omega.k = 0`.

Author(s)

A. Harris

References

Hogg (2000), arXiv:astro-ph/9905116, equation (18)

Examples

```
D.A(2.3)

z <- seq(0.1, 5, 0.1)
d <- D.A(z)
plot(z, d/max(d), t='l', xlab='z', ylab='Normalized D.A')
```

`D.L` *Luminosity distance*

Description

Function computes luminosity distance in a flat cosmology.

Usage

```
D.L(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Luminosity distance in Mpc

Author(s)

A. Harris

References

Hogg (2000), arXiv:astro-ph/9905116, equation (21)

Examples

```
D.L(2.3)
```

`D.M` *Comoving distance*

Description

Function computes comoving distance in a flat cosmology.

Usage

```
D.M(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Comoving distance in Mpc

Note

For flat universe, `omega.k = 0`, so transverse and line-of-sight comoving distances are equal.

Author(s)

A. Harris

References

Hogg (2000), arXiv:astro-ph/9905116, equations (16) and (15)

Examples

```
D.M(2.3)
```

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dComovVol *Differential comoving volume*

Description

Function computes differential comoving volume in a flat cosmology.

Usage

```
dComovVol(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Differential comoving volume in Mpc^3

Author(s)

A. Harris

References

Hogg (2000), arXiv:astro-ph/9905116, equation (28)

Examples

```
dComovVol(2.3)
```

`dimmingFactor` *Flux dimming factor*

Description

Function computes flux dimming factor in a flat cosmology.

Usage

```
dimmingFactor(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Flux dimming factor, unnormalied. Mathematically, it is `(1+z)/D.L^2`. This is the factor that scales luminosity densitiy in the observed frame to flux density in the observed frame.

Author(s)

A. Harris

References

Hogg (2000), arXiv:astro-ph/9905116: section 7, part of equation (22)

See Also

`D.L`

Examples

```
z <- seq(0.1, 5, 0.1)
df <- dimmingFactor(z)
plot(z, df/max(df), t='l', xlab='z', ylab='Normalized dimming factor')
```

`lineLum` *Line luminosity*

Description

Compute rest-frame line luminosity.

Usage

```
lineLum(intInt, z, f.rest = 115.27, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`intInt`	Integrated intensity in Jy km/s
`z`	Redshift
`f.rest`	Line rest frequency in GHz
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Value

Rest-frame line luminosity in solar luminosities.

Note

For flat universe, `omega.k = 0`.

Author(s)

A. Harris

References

Solomon, Downes & Radford (1992), ApJ 398, L29, equation (1)

See Also

`Lprime`

Examples

```
snu <- 1.e-3 # 1 mJy peak
wid <- 400   # 400 km/s wide
intInt <- 1.06*snu*wid  # Gaussian line
z <- 2.3
lineLum(intInt, z)
```

`lookbackTime` *Cosmic lookback time*

Description

Compute cosmic lookback time given z and cosmological parameters

Usage

```
lookbackTime(z, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`z`	Redshift
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Details

Defaults for `omega.m`, `omega.lambda`, and `omega.m`, are from WMAP cosmology; `omega.k` (curvature term) is computed from relationship between `omegas` in flat cosmology (`omega.k = 0`).

Value

Lookback time in Gyr.

Author(s)

A. Harris

References

"Principles of Physical Cosmology," P.J. Peebles, Princeton c. 1993, (5.63); "Distance Measures in Cosmology," Hogg (2000), arXiv:astro-ph/9905116, equation (30); "First-year WMAP observations...", Spergel et al., ApJS 148:175 (2003)

Examples

```
# lookback time for z = 2
lookbackTime(2)
# Inverse problem, age of Earth (4.6 Gyr) example:
uniroot(function(x) lookbackTime(x) - 4.6, c(0,2))$root
```

Lprime *Line luminosity, L'*

Description

Compute L' line luminosity

Usage

```
Lprime(intInt, z, f.rest = 115.27, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

intInt	Integrated intensity in Jy km/s
z	Redshift
f.rest	Line rest frequency in GHz
omega.m	Omega matter parameter
omega.lambda	Omega lambda parameter
H.0	Hubble constant in km/s/Mpc

Value

Rest-frame line luminosity in `K km/s pc^-2`.

Note

For flat universe, `omega.k = 0`. Useful for empirical mass estimates. L' is proportional to the brightness temperature of the transition.

Author(s)

A. Harris

References

Solomon, Downes & Radford (1992), ApJ 398, L29, equation (3)

See Also

`lineLum`, `mass.CO`

Examples

```
snu <- 1.e-3 # 1 mJy peak
wid <- 400   # 400 km/s wide
intInt <- 1.06*snu*wid  # Gaussian line
z <- 2.3
Lprime(intInt, z)
```

`mass.CO` *Molecular mass*

Description

Compute molecular mass (default CO J = 1-0) from L' and empirical conversion factor.

Usage

```
mass.CO(intInt, z, alpha = 0.8, f.rest = 115.27, omega.m = 0.27, omega.lambda = 0.73, H.0 = 71)
```

Arguments

`intInt`	Integrated intensity in Jy km/s
`z`	Redshift
`alpha`	Empirical mass conversion factor, see details
`f.rest`	Line rest frequency in GHz
`omega.m`	Omega matter parameter
`omega.lambda`	Omega lambda parameter
`H.0`	Hubble constant in km/s/Mpc

Details

`alpha` is an empirical mass conversion factor. The exact value is a topic of considerable debate. For CO, see Solomon and Vanden Bout (2005), also Tacconi et al. (2008) for reviews.

Value

Gas mass in solar masses.

Author(s)

A. Harris

References

Solomon, Downes & Radford (1992), ApJ 398, L29, equations (3) and (4); Solomon & Vanden Bout (2005) ARA&A 43, 677; Tacconi et al. (2008) ApJ 680, 246.

See Also

`Lprime`

Examples

```
snu <- 1.e-3 # 1 mJy peak
wid <- 400   # 400 km/s wide
intInt <- 1.06*snu*wid  # Gaussian line
z <- 2.3
mass.CO(intInt, z)
```

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