```python
# -*- coding: utf-8 -*-
"""
Created on Sat Apr 19 13:53:14 2025

@author: areyendhu
"""

import pandas as pd
import numpy as np
from astropy.coordinates import SkyCoord
from astroquery.vizier import Vizier
from astropy import units as u
from astropy.cosmology import Planck15 as cosmo
Vizier.VIZIER_SERVER = "https://vizier.cds.unistra.fr"
df = pd.read_csv("C:/Users/rahul/Downloads/WHL_orig_catalogue (1).txt", delim_whites
if df.columns[0] != 'SCL':
    df.columns = ['SCL', 'RA_cl', 'DEC_cl', 'RA_BCG', 'DEC_BCG', 'redshift', 'Size',
df = df.rename(columns={"RA_BCG": "RA", "DEC_BCG": "DEC", "redshift": "z"})
Vizier.ROW_LIMIT = 1
v = Vizier(columns=['AllWISE', 'RAJ2000', 'DEJ2000', 'W1mag', 'W2mag'])
df['W1mag'] = np.nan
df['W2mag'] = np.nan
for i, row in df.iterrows():
    try:
        coord = SkyCoord(ra=row['RA'] * u.deg, dec=row['DEC'] * u.deg)
        result = v.query_region(coord, radius=20 * u.arcsec, catalog="II/328/allwise
        if result:
            res = result[0]
            df.loc[i, 'W1mag'] = res['W1mag'][0]
            df.loc[i, 'W2mag'] = res['W2mag'][0]
        else:
            print(f"No VizieR match for row {i}")
    except Exception as e:
        print(f"Error on row {i}: {e}")
df = df.dropna(subset=['W1mag', 'W2mag'])
if len(df) > 0:
    df['W1_W2'] = df['W1mag'] - df['W2mag']
    lum_dist = cosmo.luminosity_distance(df['z'].values).to(u.pc).value
    DM = 5 * np.log10(lum_dist) - 5
```

```python
df = df.dropna(subset=['W1mag', 'W2mag'])
if len(df) > 0:
    df['W1_W2'] = df['W1mag'] - df['W2mag']
    lum_dist = cosmo.luminosity_distance(df['z'].values).to(u.pc).value
    DM = 5 * np.log10(lum_dist) - 5
    df['M_W1'] = df['W1mag'] - DM
    M_sun_W1 = 3.24
    df['L_W1'] = 10 ** (-0.4 * (df['M_W1'] - M_sun_W1))
    a = -2.54
    b = -0.17
    log_ML = a * df['W1_W2'] + b
    df['logMstar'] = np.log10(df['L_W1']) + log_ML
    df['Mstar'] = 10 ** df['logMstar']
    df[['RA', 'DEC', 'z', 'W1mag', 'W2mag', 'W1_W2', 'M_W1', 'L_W1', 'Mstar']].to_cs
    print("✅ Mass estimation complete. Results saved to 'BCG_mass_estimates_vizier.
    print(f"🔍 Matched WISE sources: {df['W1mag'].count()} out of {len(df)}")
else:
    print("⚠️ No WISE sources matched. Try reviewing radius or input coordinates.")
```

```
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IPython 8.12.0 -- An enhanced Interactive Python.

In [1]: runfile('C:/Users/rahul/untitled2.py', wdir='C:/Users/rahul')
✅ Mass estimation complete. Results saved to 'BCG_mass_estimates_vizier.csv'
🔍 Matched WISE sources: 661 out of 661
```

```python
# -*- coding: utf-8 -*-
"""
Created on Sat Apr 19 14:10:43 2025

@author: areyendhu
"""

import pandas as pd
import numpy as np
file_path = r"C:\Users\rahul\OneDrive\Desktop\BCG_mass_estimates_vizier.csv"
df = pd.read_csv(file_path)
print("Available columns:", df.columns)
if 'Mstar' not in df.columns:
    raise KeyError("Column 'Mstar' not found. Please check the CSV file.")
df['log_mass'] = np.log10(df['Mstar'])
def classify_galaxy(log_mass):
    if log_mass < 9:
        return 'Dwarf / Irregular'
    elif 9 <= log_mass < 10.5:
        return 'Spiral'
    elif 10.5 <= log_mass < 11.5:
        return 'Elliptical'
    else:
        return 'Giant Elliptical / BCG'
df['galaxy_type'] = df['log_mass'].apply(classify_galaxy)
output_file = r"C:\Users\rahul\OneDrive\Desktop\BCG_mass_classified.csv"
df.to_csv(output_file, index=False)

print(f"✅ Galaxy classification complete.\n📁 Results saved to:\n{output_file}")
```

```
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IPython 8.12.0 -- An enhanced Interactive Python.


In [1]: runfile('C:/Users/rahul/untitled6.py', wdir='C:/Users/rahul')
Available columns: Index(['RA', 'DEC', 'z', 'W1mag', 'W2mag', 'W1_W2', 'M_W1', 'L_W1', 'Mstar'],
dtype='object')
✅ Galaxy classification complete.
📁 Results saved to:
C:\Users\rahul\OneDrive\Desktop\BCG_mass_classified.csv
```