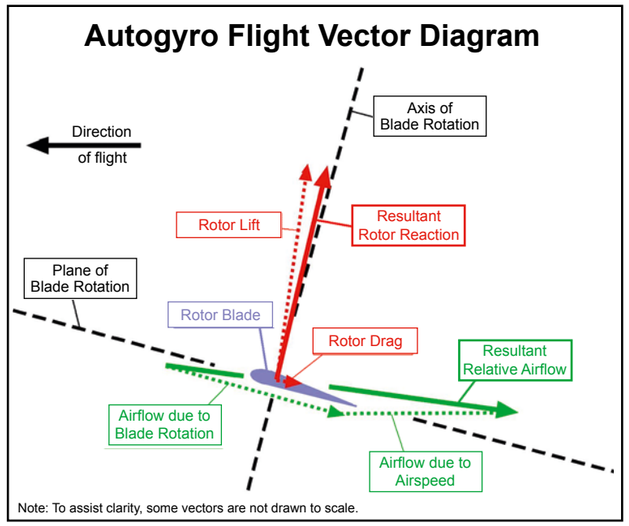
They fly by magic, or some other technical theory

ON SEEING an autogyro for the first time, many people are surprised to find that there is no in-flight drive system to the rotor blades, especially after watching these aircraft perform what may sometimes seem like extreme manoeuvres.

So other than magic, what keeps the rotors turning? Autogyros fly by the principle of autorotation – the same way helicopters can glide to the ground and land in the event of engine failure. The big difference is that autogyros fly permanently in autorotation, sustained by using a propeller to drive the aircraft forward through the air. Whereas a helicopter rotor is tipped forward in forward flight (directing the resultant rotor reaction up and forward) and pulling the aircraft through the air, the gyro rotor is tipped back such that air passes through the front of the rotor disc from underneath. Although a rearward component to the resultant rotor reaction then exists, this is more than compensated for by the forward thrust of the propeller.



In a turning rotor system there exists an airflow due to aircraft movement and also an airflow due to blade rotation. These sum to a resultant relative airflow which in autorotation is directed across the aerofoil from below the plane of rotation (remember the rotor disc is tipped back). Therefore lift, which is perpendicular to relative airflow, is directed forward of the axis of rotation. In autorotation the resultant total reaction of rotor lift and rotor drag is still forward of the axis of rotation so in addition to providing lift, this force also drives, or rotates the rotor forward.

Because the rotor sees a much greater airflow at the blade tips than the centre, it follows that different regions of the disc experience different forces. In autorotation, the described force is dominant however and providing there is sufficient relative airflow due to either forward or downward aircraft movement (or simply the wind itself), the autorotation effect is self sustaining. Not magic at all, as the vector diagram demonstrates. During a take-off roll, as airspeed is increased, the autogyro rotor system will turn faster and faster by itself until enough lift is generated to fly. After that, rotor speed is self governing depending on rotor load.

Nearly all gyros have a fixed pitch rotor system with the advantage that so long as airflow continues to pass through the front of the rotor disc from underneath, the rotor cannot be stalled and hence it is possible to slow a gyro to zero forward airspeed. It's an eerie sensation for fixed wing pilots. The result will be descent but the rotor system will continue autorotating and the pilot needs simply to lower the nose of the aircraft to regain sufficient forward airspeed for initiating a flare and slowing the descent rate before the ground arrives.

Another autogyro benefit is that these aircraft can enjoy a very short takeoff roll, especially if there is a little wind on the nose to begin with and if a good pre-rotator is used. A pre-rotator is a mechanical device connected to the engine with a clutch arrangement allowing the rotors to be spun up to near flight speed while the aircraft is stationary. The clutch will then be disengaged (eliminating any torque reaction) before commencing a short ground roll to accelerate the rotor sufficiently further for takeoff.

The most significant advantage however, is simplicity. The standard autogyro rotorhead does not require the helicopter complications of a primary driveshaft, swash plate, feathering hinges or pitch links, and with most gyros using a semi-rigid two blade rotor system, lead-lag and flapping hinges are not required either. Nor of course is a tail rotor. It's a great way to fly.

Given the great simplicity of the autogyro flight system and the fact that landings (including engine off deadstick landings) can be accomplished with very little, or zero groundspeed, autogyros are also arguably a very safe way to fly. In fact, if choosing an aircraft to experience an engine failure in, autogyros would have to be at the top of the list. Try one and be surprised! Beware of addiction though – it's happened to many before you.